



Home Owners' Hand-Book

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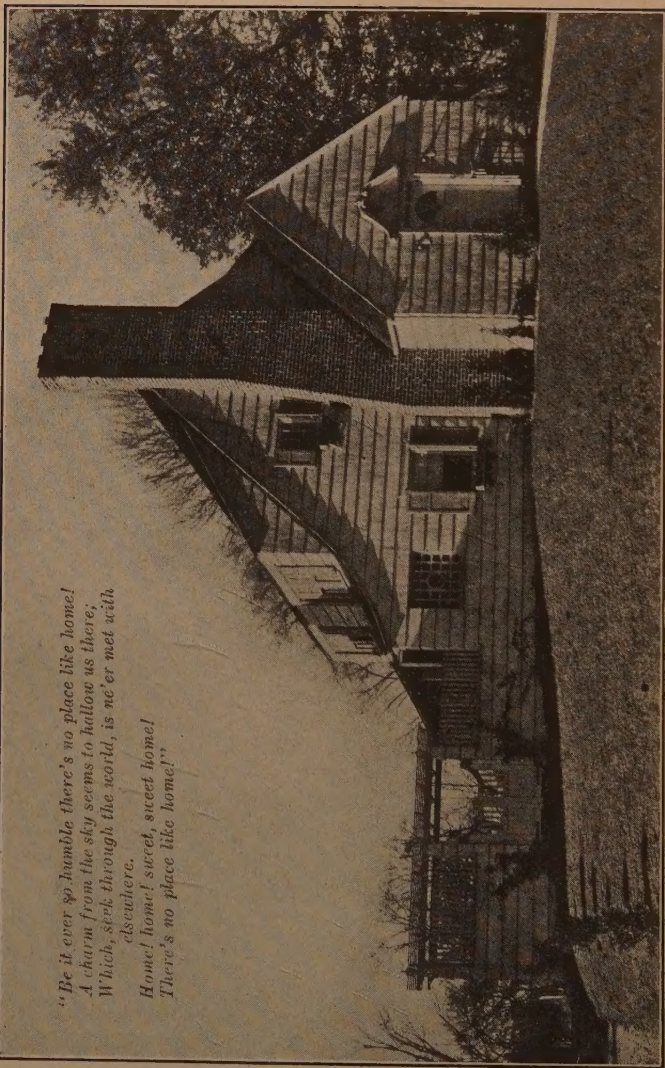
AUSTIN C. LESCARBOURA

Isaac C. Palmer.

SCIENTIFIC AMERICAN
HOME-OWNERS'
HANDBOOK

*"Be it ever so humble there's no place like home!
A charm from the sky seems to hallow us there;
Which, seek through the world, is ne'er met with
elsewhere.*

*Home! home! sweet, sweet home!
There's no place like home!"*



SCIENTIFIC AMERICAN HOME-OWNERS' HANDBOOK

*A vast fund of useful information for
the man who is planning to buy or build
a home, and for that same man when
he becomes a home-owner in fact as well
as in desire.*

By AUSTIN C. LESCARBOURA
Managing Editor, Scientific American

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PREFACE

IF houses could be bought for \$100 each, this book would never have been written. Instead, even the modest bungalow without frills or thrills costs fifty times that much—\$5,000 or more—a vast sum for the average man. Indeed, the greatest investment which the typical family is ever called upon to make is the purchase of a home. Not only does this investment call for the better part of the available cash, but it usually binds the family to serious financial obligations extending over a long period of years.

The greatest investment of a lifetime! Yet how much does the average man know about land and houses and mortgages and titles and the hundred-and-one other details of buying a home? Truth to tell, very, very little. Hence we have the everyday case of the average man plunging into the greatest investment of a lifetime with little or no knowledge of what it all means. He is under the firm impression that he is gaining possession of a place to live in; that he is at last emancipated from the rule of the landlords; that he is lord

and master of a little place all his own. The house pleases him. He likes the surroundings. The terms of the deal apparently come within the limitations of his pocketbook, especially the initial small cash payment. The good wife is highly satisfied, because of the attractive color scheme of the exterior, the cute shutters, the beautiful front door, the pretty sun-parlor and the cozy dining alcove, the ivory woodwork throughout the house, the tiled bathroom, and the Roman bathtub.

Superficially, therefore, everything is fine. It should be that way through and through; but, unfortunately, there is more to buying a house than the superficial details. First, there is the question of the house proper—the materials entering into its construction, the honesty of the builder and his workmen, the framing which cannot be seen, the foundation, the footings out of sight under the ground, the roof, the heating plant, the hidden plumbing and the electric light wiring. Secondly, there is the matter of the title and other details regarding land rights and transfers. Thirdly, there is the question of the cash payment and the balance due on the house, which can be taken care of by mortgage, contract, or a building and loan arrangement. These things, after all, are the real essentials of the proposition. The dining alcove and the Roman bathtub and other items which have swayed the purchaser in his decision, are mere details.

And the essentials remain long after the thrill

of possession has been forgotten. The essentials determine whether the occupants of the house will be happy and comfortable. The essentials determine the amount of money that must be expended from time to time on repairs and general upkeep. The essentials determine whether the title to the land can ever be questioned. The essentials, finally, determine whether the terms of payment can be comfortably met or whether the house must ultimately be sacrificed because of the crushing financial burden.

All of which is by way of justifying this work. The author has been through the experience of buying a home, arranging mortgage terms, discovering plenty of unexpected trouble due to faulty construction, and finally selling the house through sheer disgust. An experience of this kind drives home the necessity of certain kinds of information before another venture of this kind is attempted.

Over four hundred building material companies and associations were asked for their literature. Over two hundred and seventy-five pounds of reading matter was received. This vast accumulation of information, dealing with every conceivable phase of home building, was gone over in detail with the object of obtaining such information as would be of pertinent interest to the average man about the build or buy a home. This information, together with a fair sprinkling of first-hand experience, produced the present work.

The author is indebted to the building material companies in general for their excellent informative literature and their unselfish co-operation. He owes much of the information contained in this book to the Bureau of Standards, which has done so much to take the gamble out of home building and home buying. Many of the explicit drawings in this book are reproduced through the courtesy of the Weyerhaeuser Forest Products organization, who have also supplied material for much of the text on various details of building construction, and the Copper and Brass Research Association. The Architects' Small House Service Bureau publications have supplied many little pointers scattered throughout this work. The brick manufacturers associations, the Portland Cement Association, the lumber and the terra cotta organizations have contributed information on their respective products.

It is sincerely hoped that the efforts of all these building material companies and associations, Government bureaus, architects' organizations and other agencies, combined with the efforts of the author in preparing this compilation of essential and readily-understood data, will do much to discourage the building and the buying of houses which can never be called homes.

THE AUTHOR

Croton-on-Hudson
February 25th, 1924

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CHAPTER I.

THE HOME—WHAT IT IS AND WHAT IT MEANS

HOME—how much that word stands for! Songs have been composed about home. Poems have been written about home. Home is the theme of many stories. Home is the outstanding thing in the average life. Virtually every ambitious person wants to own a home of his or her own, some day. Some prefer to buy a home already constructed. Others prefer to build their own, in order to have something truly individualistic. But in any event it is a home, and that means much.

TO BUY, BUILD, OR RENOVATE—THAT IS THE QUESTION

A house is a house until it becomes your own. It then is no longer a house but a home. There are three ways of going about getting a home: first, buying a house that is already built; secondly, building a house to suit one's particular needs, taste, and pocketbook; thirdly, buying an old house which may be renovated and improved so as to make it a desirable home.

In these days of inflated real estate values, it soon

becomes evident to the home seeker that the prices of standing houses are generally excessive. The trouble here is that the owners of a standing house wish to realize a handsome profit on the sale, so as to make it amply worth their while. As often as not the present owners have bought from the previous owners, who also made a handsome profit. The owner before them also made a profit, and so it goes. Thus a house that may have cost \$5,000 to construct, including the land, has passed through three or four profit-making hands, with the final price at \$12,000 to \$15,000. As things now look it seems very much as though the buyer of today pays the top price and faces a very small opportunity of ever clearing out in the future with the money he has put in, let alone making even a small profit.

It's a disease, truly, this business of boosting up the price of a house, and almost every buyer of a house feels that he has driven a good bargain. Invariably the buyer will tell you that the house he bought yesterday is already worth anywhere from ten per cent to fifty per cent what he paid for it. The favorite pastime of the home-owner is to figure with pad and pencil how much he is worth, based on what he thinks he could get on his house. But why interfere with such harmless sport!

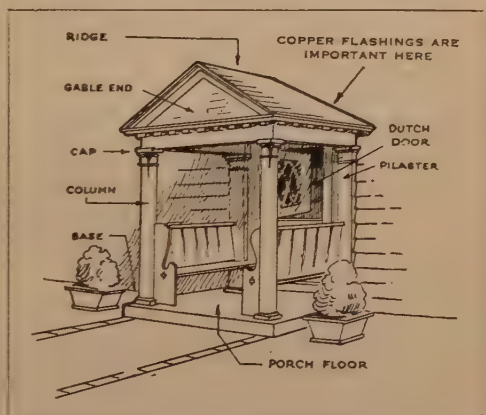
Just so long as this frame of mind is universal, the prices of standing houses are bound to remain excessively high and nothing can be done about it. Purchasing a standing house has its advantages, to be sure. For the man who dreads to undertake the responsibilities and troubles coincidental to building a house, the purchasing of a standing house represents a ready and simple solution. Perhaps he may be paying for the convenience, but then it may be worth while. Then, too, the standing house is something tangible and definite. You see it exactly as it is. It

is a case of take it or leave it. There are no disappointments later on—at least, there should be none if the house has been thoroughly inspected before purchase.

BUILDING YOUR OWN

Allowing that the cost of building is excessively high, due to the cost of building materials as well as labor, the excessive prices asked for standing houses offset this high cost. Thus it is sometimes cheaper to build a house, and certainly more desirable, since in this manner a new, clean, up-to-the-minute house is obtained. Again, building the house permits of obtaining exactly what the owner desires. It is a made-to-order product instead of a ready-fit proposition.

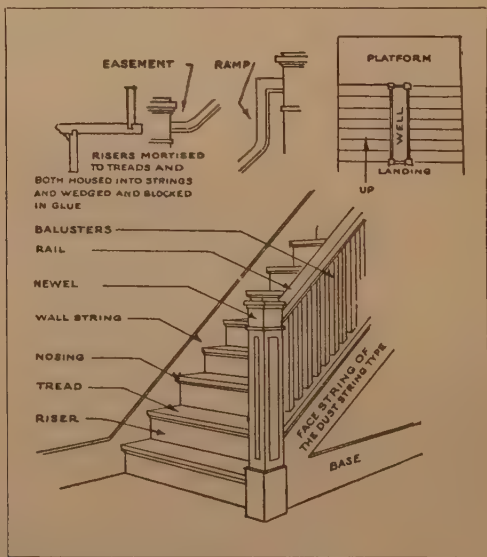
One of the talking points in favor of building-your-own plan is that the exact site of the home may be selected, whereas with the standing house the location may not be all that is desired. This, of course, is often double-edged. Thus in the case of a standing



Details of a porch, giving the names of the various members. Other details of the house are given in other drawings presented with this chapter.—(Courtesy Copper & Brass Research Association.)

house one often gets fruit trees and other natural features which require years to duplicate in the case of a new house and grounds.

The building of a house entails a considerable amount of trouble. The ground must be bought; plans must be obtained; certain legal technicalities must



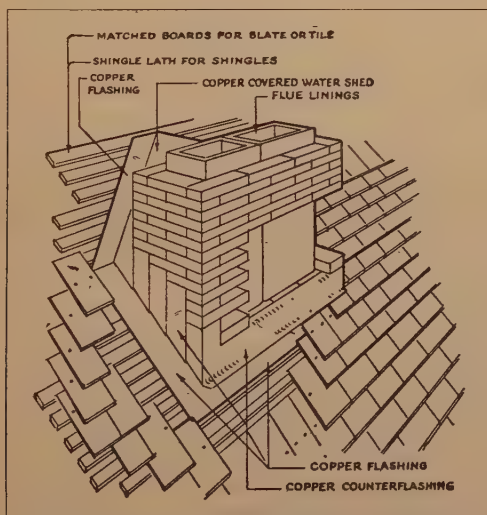
The stairway, showing the various details and giving the correct terms in the language of the builder.—(Courtesy Copper & Brass Research Association.)

be observed; financing arrangements must be worked out, if the full amount is not available; the work must be arranged for by means of contracts or other arrangements; the materials must be bought; and so on. It is the responsibility of all these details that many home-seekers shirk, and therein lies the demand

for standing houses at almost any cost as compared with better value and greater satisfaction, in most instances, available through building-your-own.

THE MATTER OF REBUILDING OR RENOVATING

There is a third way out of the home-owning problem, and that is to purchase an old, standing house and to rebuild or renovate it. Of late years this



Details of roof construction and the chimney. The drawing shows shingle lath which is used as a support for wood shingles. When composition or other shingles are used, matched boards are laid for the support.—(Courtesy Copper & Brass Research Association.)

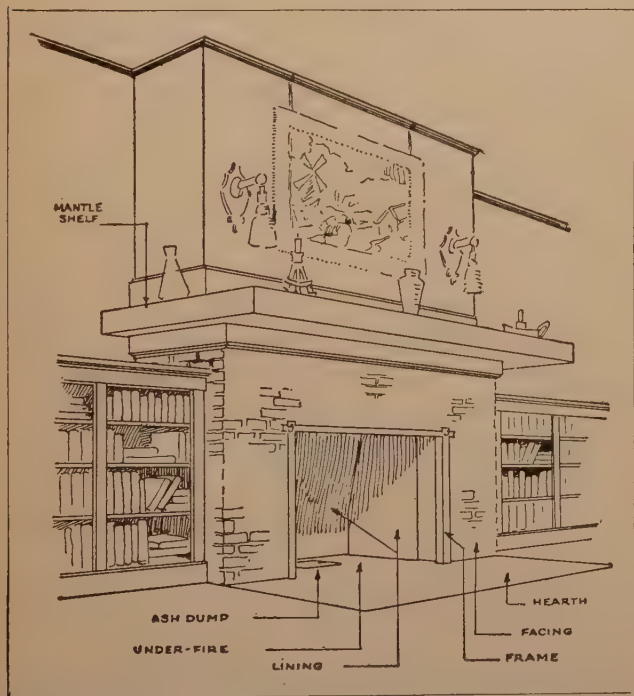
method of securing a home has been most popular, for the reason that many prefer not to undertake the construction of a new house in these days of high

costs and labor shortage, yet are discouraged from buying a new house or a fairly new house because of the high prices asked. Then, too, there are many advantages connected with the purchase of an old house.

First of all, the old house has a setting that has taken many years to create. Fine trees are not grown overnight, especially in the case of large shade trees and fruit trees. Secondly, houses in need of repair and up-to-date facilities must be sold at a decidedly low price if they are to attract buyers. Therefore, dollar for dollar, it is generally possible to obtain better value in these old houses. Thirdly, old houses have a touch of romance or something which is not found in a brand new or a fairly modern house. Especially in these days when architectural design is reverting back to our simple Colonial styles, the old house lends itself to charming exterior treatment.

This matter of buying and renovating an old house should be entered into with due care. It should be borne in mind that a low first price is by no means the only consideration. After the house is bought, it is necessary to make a number of improvements and repairs before it is livable. And in order that the house may prove a good investment, it is essential that the house be fundamentally sound. If the main timbers are rotted and the house sags, it had best be left alone irrespective of low cost, for no amount of subsequent repairs within reason will make it livable. But if the house is fundamentally sound, it is a simple matter to figure on such improvements as plumbing, heating plant, electric light, paint, interior decoration, new floors, and so on. The beauty of such an arrangement is that all the improvements and repairs need not be made at once. Thus the buyer puts in the essentials to begin with, and then makes the improvements and repairs one by one as he has the necessary funds for such items or as he finds the necessary time

to do the work himself. Indeed, such a house presents an interesting problem in home making; and there is far more romance and satisfaction in remodeling



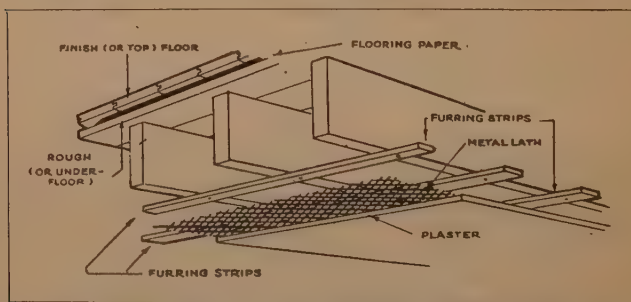
The fire-place, indicating the various details and what they are called.—(Courtesy Copper & Brass Research Association.)

an old house than there is in stepping into a brand new house which requires absolutely no fixing up of any kind and presents no opportunities for one's own little touches.

WHAT TO LOOK FOR IN BUYING A HOUSE

Buying a house is, for the average family, a thrilling venture. It involves the greater part of the family capital, as a rule, and as often it involves a financial obligation extending over a period of years. For that reason the matter must be approached with all due caution, for it is quite possible to make a blunder which cannot be readily undone.

In this chapter we concern ourselves only with the house proper, and not with the questions of land and titles, mortgages and taxes, lawyers and legal technicalities, and so on. Those questions are reserved for



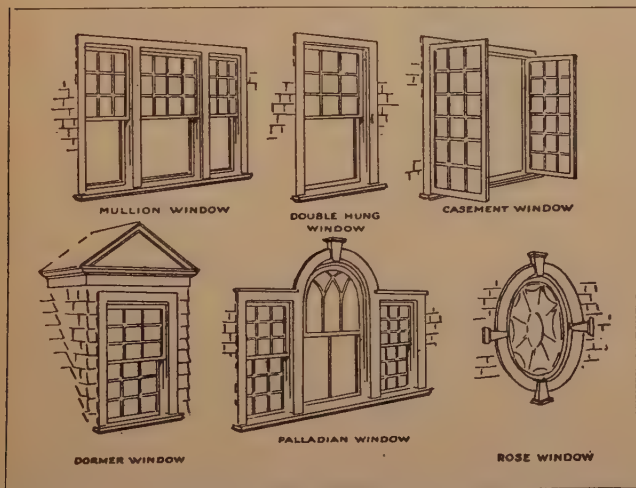
Floor and ceiling detail. This represents the best type of construction, with double floors, flooring paper, and metal lath.—
(Courtesy Copper & Brass Research Association.)

the next chapter, where they are dwelt with at length. Our intention here is to consider the house by itself.

A house is a composite. It is made up of walls foundations, roof, inside finish, windows and doors, plumbing, electric light wiring, heating plant, and numerous accessories. The house may be made exceedingly attractive both inside and outside, if it has been constructed with some architectural skill. Still, architectural design, important as it is from an aes-

thetic standpoint, contributes very little towards the house as houses go. The important thing about a house is that it be substantially built so that it will stand for many years to come, and so that it will withstand the elements and give protection to its occupants. These are the essentials—the cardinal things that count. Whether it has a built-in soap dish in the bath-room or a beautiful white-enameled cabinet in the kitchen or a beautiful Dutch front door, is merely a detail. Only too often the inexperienced buyer is swayed by little touches such as these, while overlooking the very essentials that go to make a good house or a bad house.

In these days of high building costs it is not uncommon for speculative builders to skimp on every possible detail. A minimum of lumber is employed,



Various types of windows which are found in American dwellings. Other window details are given on pages 19, 20 and 21.—(Courtesy Copper & Brass Research Association.)

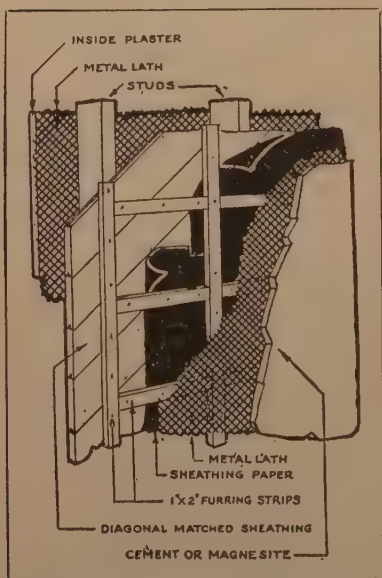
and such lumber as is used is under-sized in many instances. The houses thus built lack the stability and standing qualities of pre-war construction, but unfortunately they are dressed up with attractive lines and paint and a few fancy touches here and there to catch the unwary buyer.

In this connection the story is told of two speculative builders who were putting up houses by the row.

One night a heavy windstorm came up, with the result that one contractor's row of houses was blown down, while the other contractor's was left standing. Said the first contractor to the second contractor: "You are darned lucky. Look what happened to my houses, which were built the same as yours! Why didn't yours blow down?" To which the second contractor answered with a smile: "Well, you see, I had the jump on you. My houses had been papered when this windstorm came up!"

Far fetched as that story may sound, it unfortunately has

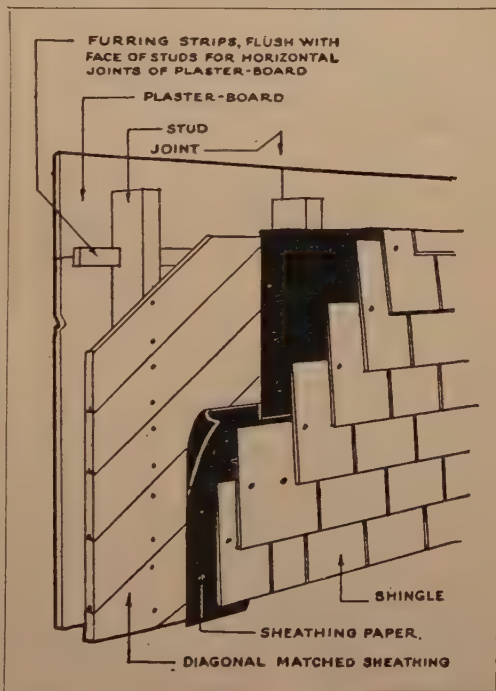
some basis in truth. It is a fact that some speculative



Detail of a stucco wall, showing the framework studs, the metal lath for inside and outside coats, the sheathing and sheathing paper, and the furring strips.—(Courtesy Copper & Brass Research Association.)

houses are built with a minimum of framing, so that the builder depends largely on the lath and stucco coat for bracing. Unfortunately, a house already standing must by the very nature of its construction hide the very members which should be carefully examined. Between the outside wall and the inside wall are the framing members, and once these are covered in the buyer has difficulty in determining how substantial the house really is. Furthermore, the finished house produces the impression of solidity, no matter how very poorly it may be built; and therein lies the danger to the buyer.

As a general rule it is dangerous to buy houses built for speculation. The terms are often so attractive that other considerations are al-



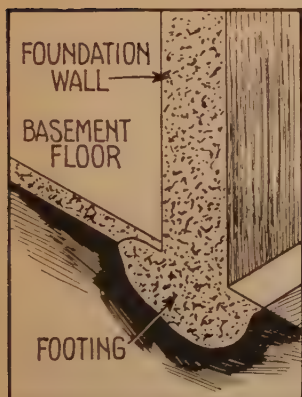
Details of a shingled wall, showing the framework, plaster boards, sheathing and paper, and outside shingles.—(Courtesy Copper & Brass Research Association.)

most entirely forgotten. The house offered by a private individual is generally a safer "buy", especially if the house has been built on contract in the first place, and not purchased from a speculative builder. Still, it should be remembered that there are many reasons why a house is being sold, and these reasons should be studied, if possible. Sometimes there is something decidedly wrong with the house that causes the owner to sell. Finally, the safest investment today in the way of a standing house is a pre-war house—say a house built back in the years just preceding 1918, when building costs were still reasonable and building construction was uniformly honest. Such a house may not have the latest wrinkles in the way of design and conveniences, but its essentials will be better, as a rule, than the post-war houses.

THE THINGS THAT COUNT

In considering a house the first thing is the foundation. Start with the basement. If the floor of the cellar is damp and the walls fairly drip with moisture, it is a sign that the house lacks rain leaders and has improper drainage around the foundation wall. Next, examine the cellar wall carefully for signs of cracks. Cracks indicate uneven settling due to improper footings or supports under the foundation walls, and such settling is transmitted to the structure above, resulting in cracked plaster walls upstairs, warped woodwork, and doors that refuse to close properly. Examine the windows in the cellar walls. If streaks of daylight come in about the window frames, it indicates that the mortar has not been packed properly and that the cold winter winds as well as driving rain will come in.

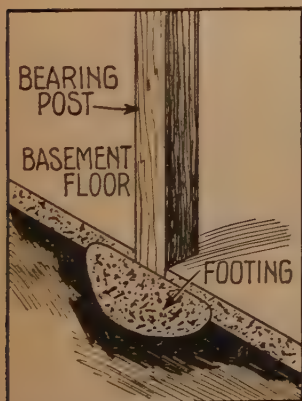
The next item is the supporting posts or bearing post that serve to uphold the center part of the house.



Details of a faulty foundation wall. Note the wedge-shaped footing, which is bound to sink down in the supporting soil with sad results.



Details of a properly-constructed foundation wall, showing the heavy, square footing and the drain tile outside in damp soil.



Details of a faulty bearing post footing which, being wedge-shaped, is almost certain to sink down.



Details of a properly-constructed footing for bearing post. Note how footing extends above floor level.

These posts should be of a wood that is strong and withstands rot. Locust is often used, and in some of the modern houses the practice is to use steel or iron pipes provided with flanges at top and bottom. The wooden posts, when used, should be resting on concrete blocks rising above the level of the concrete floor. Only too often the wooden post rests on the damp ground and the concrete floor has been laid

around it, with the result that the dampness rots the wood without showing signs of such rot. To test for such a condition, the bearing post should be given a vigorous kick, which will soon disclose any signs of advanced rot.

The cement cellar floor should be rapped with a cane or heavy stick for hollow sounds. Hollow sounds disclose imperfect cement work. Cracks should be carefully examined.

The attention should now be directed to the ceiling of the cellar, which generally consists of the beams sup-



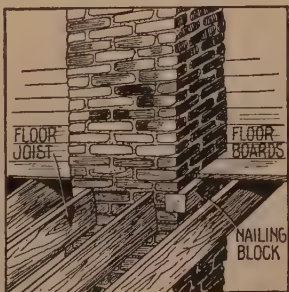
**Telltale of improper footings
for the foundation walls.**

porting the floor above. These beams or floor joists, as they are called, are generally 2 by 8 inches, and in some of the older houses they are sometimes larger. These joists should not be too long—12 feet of span is a safe limit for the 2 by 8 inches. When the joists of this size are longer, without support except at the ends, they sag in the middle and this sagging causes them to pull loose from the sub-flooring above, causing squeaks in the floor as it is walked on. The joists should also be studied to make sure that they are

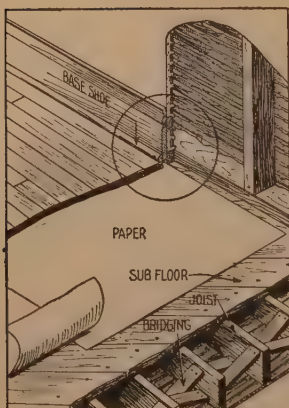
straight and in alignment. Remember, these joists and other structural members of a house are of far greater importance than the tiled bathroom or the attractive sun parlor.

The small sticks of wood that are criss-crossed between the joists are not put there for ornamentation. They are intended to keep the joists in position and, what is more important, to distribute loads over a number of joists instead of putting all the load on one or two joists. These criss-crossed sticks are known as bridging, and are of the utmost importance. Sometimes they are totally missing, which is a sign of poor construction. Again, they may be in evidence, but on closer examination they prove to be improperly nailed so that they fail in their mission.

While looking at the cellar ceiling, it is well to study the under side of the flooring. A properly built house has what is known as the sub-flooring. This is a rough flooring made of wide boards, as a rule, over which are laid the smaller boards of the finish flooring. If the boards seen by looking upwards in the cellar, appear to be quite narrow and of good wood, it is only necessary to look at the finish floor upstairs to determine whether there is but a single floor. In many of the attractive post-war houses now offered for sale, only a single floor is laid down. It may be a hardwood floor, to be sure, in order to attract the buyer and lead to the impression that everything must be of the very best. Nevertheless, if the house has a single floor it is not built in the most approved manner. Single floors



The poorest kind of construction, using the center chimney as a support for joists.



Details of good floor construction, showing double flooring, good joists, and bridging.

give under foot, as one walks on them. Furthermore, they cannot be made absolutely airtight and dust-tight, with the result that cold air and dust come up from the cellar.

If the inspection of the under side of the floor discloses a rough board floor, note if the boards are laid diagonally or at right angles to the joints. The former construction is much to be preferred, although it is a trifle more expensive in the first place. If at right angles, then note if the finishing floor is laid in the

same direction. The latter practice is unfortunate, because when the two floors are laid in the same direction it usually follows that large, unsightly cracks and waves must develop in the finish flooring.

Building paper should be found between the finish flooring and the sub-flooring. Such paper serves to prevent fine coal dust and ashes from sifting up through the cracks into the rooms upstairs. By looking at the very ends of the floor boards some signs of building paper should be discovered, if it has been used.

From the cellar, the prospective buyer should step out on the porches, which have separate supports from the house proper. Examine the supports of the porches. These should be of brick or concrete, properly constructed, or timber posts resting on a concrete footing. Only too often the porch supports will be found to be nothing more elaborate than a few

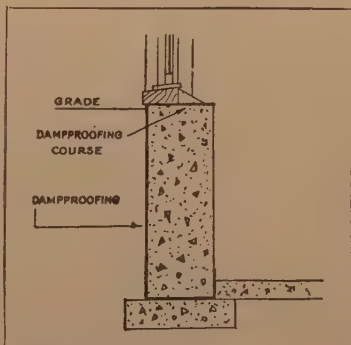
loose bricks or concrete blocks, or even posts driven into the ground. It is such faulty and sloppy construction that causes sagging porches and gives the house a hang-dog look.

TELL-TALE DOORS AND WOODWORK

Try the outside doors. They should close properly and lock properly. If they fail to close and lock properly, it is a fair indication that the framing of the house is sagging, due to the uneven settling of the foundation. Open joints in the woodwork, warped doors, stained and cracked plaster or torn or wrinkled wall paper tell a similar tale. Special attention should be paid to water marks under windows and whitened spots on floors beneath windows, since these indicate that rain drives in around the window frames. Dust streaks on the plastered walls around the window casings suggest draughty windows and excessive coal bills.

Large, jagged cracks in the plaster over the arch between the living and dining rooms tell a story of misdirected economy. Undersized framing material, lack of trussing and improper construction have been hidden behind the plaster over such an opening, but they are, nevertheless, heralding their presence.

Windows that refuse to open also disclose



Details of a properly constructed foundation, with precautions against drainage water.—(Courtesy Copper & Brass Research Association.)

faulty construction, due to sagging walls or other shortcomings.

Aside from these general details, the buyer should rely on his powers of observation. He should glance about the house and see what condition the lumber is in, if it is a frame house. Lack of paint on exposed wood will cause considerable damage to the wood in time. Porch floors should be examined, railings, clapboards, shingles, roofing, and so on. The roofing item alone is an important one, and it should be examined not only from the outside of the house but also in the attic. A worn-out roof readily denotes its presence, and presages an early repair bill of anywhere from \$100 to \$400, depending on the size of the house.

The heating plant should be studied, to determine whether it is of ample capacity to heat the house properly, and whether it is in first-class working order. The same may be said for the plumbing and the wiring.

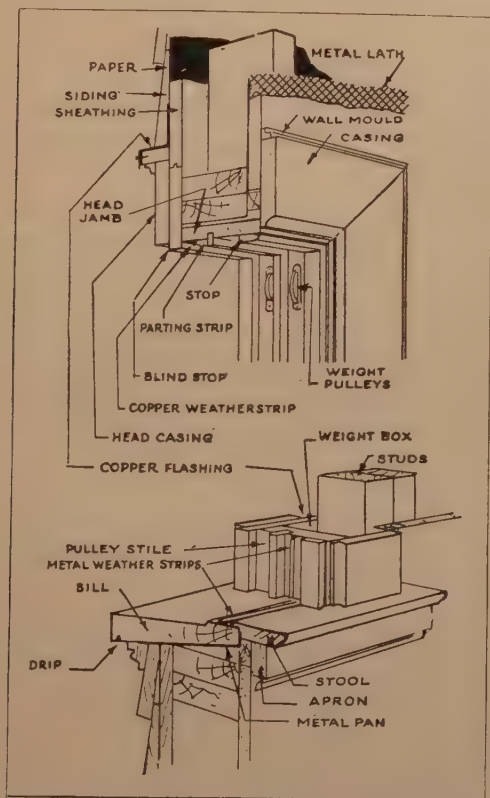
Some attention should be paid to paint and interior decoration. It should be borne in mind that if the house is freshly painted, it represents a saving of quite a sum of money to the purchaser. The same may be said for the interior decorations, although it is seldom that one family is ready to accept the decorative scheme of the previous family.

If the contemplated purchase involves a considerable sum of money, by all means call in an experienced builder for an opinion. It may mean but \$25 or even less, and in the long run this is money wisely spent. A keen builder can discover many things that may be wrong with a house, yet escape the attention of the less experienced person.

FOR THE MAN WHO BUILDS

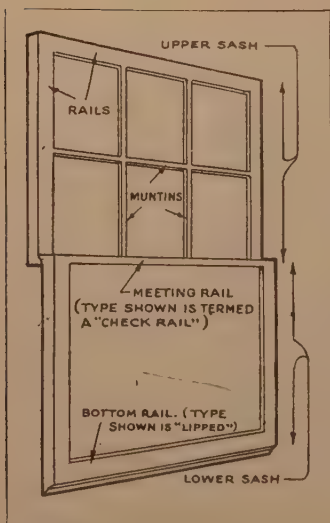
The average man purchases a pair of shoes and judges them by the amount of wear he can get out of

them. If it is a piece of furniture, he wants to know how it is built and whether it will hold together. Or



Details of a standard window frame, giving the names of the various parts.—(Courtesy Copper & Brass Research Association.)

in buying a motor car he will inquire into the quality of the engine and the amount of repair necessary to



Inside view of a window, indicating the various parts.—(Courtesy Copper & Brass Research Association.)

keep it in good operating order. But let this same man undertake the building of a home and immediately he discards his usual shrewd purchasing habits. The manner in which the house is built is apparently of little moment to him. The completed house must look well. Aside from that, anybody's construction standards will do as long as they conform to the law and will give him the house he wants in the shortest possible time and at the least cost. Here is the biggest purchase of a lifetime—the one which he knows least about, the one which undoubtedly means

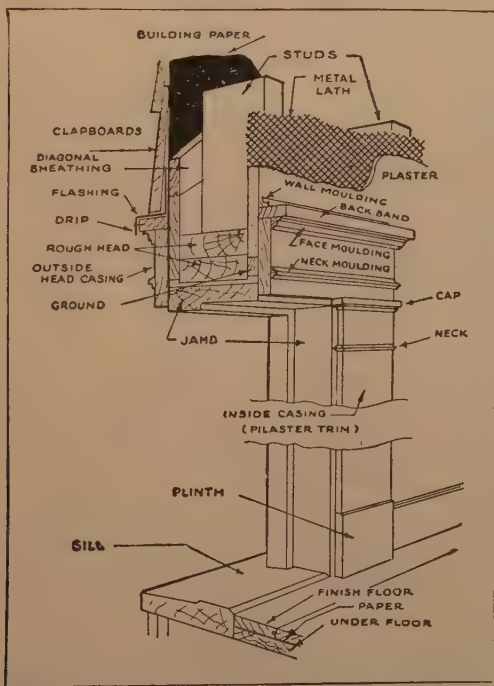
most to him, the one that will be with him the longest—treated as an insignificant article on the bargain counter.

Little wonder that there has sprung up a class of builders with low prices their principal stock in trade, with construction standards of questionable merit or adjustable to the price they get, and using these to compete with the legitimate contractor who knows how to build only honest houses.

It is not the intention here to imply that the inexpensive house is necessarily a poor or unsound house. Nor is it implied that the lavish spending of money will insure the builder getting a satisfactory home. There are economies that can be and should be prac-

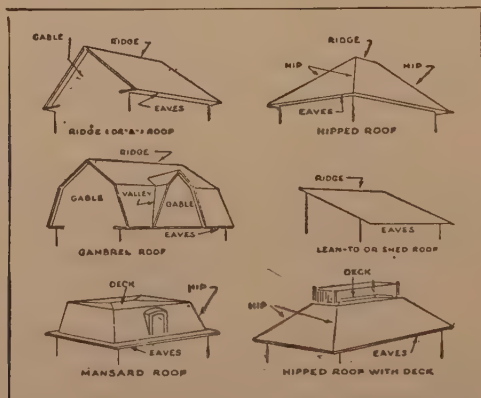
ticed in house building. The legitimate contractor knows these economies and knows how to apply them properly.

It is well for any prospective builder to bear in mind that in the history of a house is written not only the first purchase price but also the future maintenance, upkeep, and repair bills. Fifty dollars saved today by cheapening the construction of a \$5,000 house may return as a "five-times-\$50" repair bill in short order.



Details of an outside door, giving the names of the various parts.—(Courtesy Copper & Brass Research Association.)

No house can be thoroughly successful unless it combines the four basic essentials: good design, efficient plan, right material and sound construction. A house



Various types of roofs which are to be found in American dwellings.—(Courtesy Copper & Brass Research Association.)

may be large or small, elaborate or inexpensive; it may be attractively finished and may boast of every modern convenience and labor-saving device; yet without all four of these essentials it can never be a permanent, substantial, satisfactory home.

Somebody has termed house building "life's greatest puzzle." The layman who views a half-finished house with its maze of framing, scaffolding and falsework, quits the site more mystified than ever and with the belief that a man must necessarily be a born puzzle-solver in order to understand the intricacies of house building.

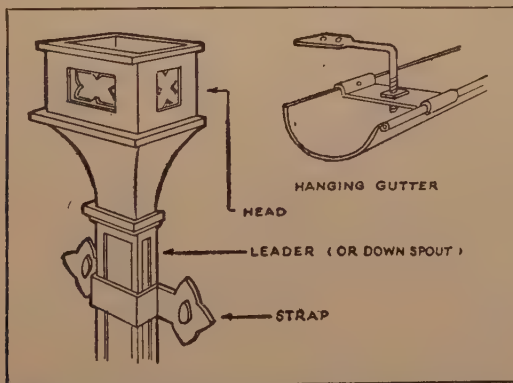
And yet this matter of house building is not such a difficult one to master. A house has comparatively few main parts and its erection is not nearly so com-

plicated a procedure as the average person supposes. Indeed, most people are agreeably surprised after a little study and observation of houses under construction to find how easily the puzzle solves itself.

Consider for a moment this simple grouping of the principal parts of a house frame: the foundation; the floor framework, consisting of bearing posts, girders, and joists; the walls and partitions built of studding; and the roof. All of the other framing members are incidental to one or another of these parts.

There have been scattered throughout the text of this chapter numerous sketches showing the various features of house construction, together with the names in order that the layman may obtain some idea of the subject as well as the nomenclature.

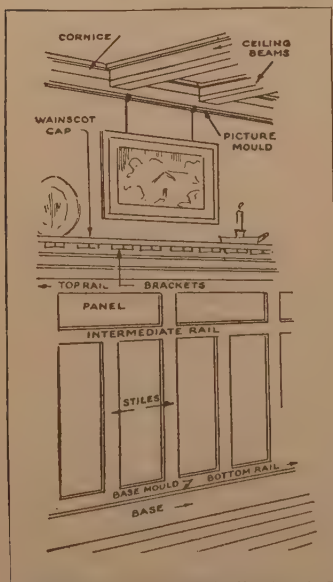
As to the type of house to build, this is entirely a matter of taste and pocketbook. The house may be a single story bungalow with or without cellar; it may be a story-and-a-half story bungalow, in which the attic space is put to good use in the form of bedrooms and



Details of the hanging type of gutter and the leader or down spout.—(Courtesy Copper & Brass Research Association.)

bathroom; it may be a full two-story house with attic. Again, the house may follow any desired architecture,

from the rather severe New England Colonial to the Spanish Mission, or from the California bungalow to the Italian Renaissance, or from the Dutch Colonial to the English cottage. The architecture is largely a matter of taste—with some consideration for the pocket-book. At any rate, whatever design is used, it is well to give considerable thought to architectural considerations. Time and again a builder will go ahead on a set of amateur plans, in order to save a few dollars on the initial cost. Nothing can be more foolish, for the finished product often is disappointing. In these days of excellent stock plans, it is nothing short



Details of interior trim as found in a paneled room.—
(Courtesy Copper & Brass Research Association.)

of folly to go ahead with

an amateur plan.

CHAPTER II.

THE BUSINESS OF GETTING LAND AND GETTING A HOUSE

BUILDING or buying a home is a great event in the life of the average man. It is a transaction that requires the use of sound judgment to the end that a home of lasting value will be obtained for the family on the one hand, and that this home will come within the financial means for the present and the future. A home must never be a financial strain. If this point were given the consideration which is due it, there would be more happy homes today. As it is, too many home builders and home buyers are carried away with the urge to obtain the finest possible home, and they overstep their financial capacity with unfortunate consequences.

However, enough of the gloom stuff. This book is intended as a cheerful and helpful guide to home-buying and home-building, and with that word of warning regarding financial limitations, we pass on to the most fascinating business of getting a piece of land and a real home.

THE QUESTION OF BUILDING SITE

Whether one buys a standing house or sets out to build a house, the first consideration is the building

site. This is one of the greatest, if not the greatest, problem involved. The site or location is something which remains more or less fixed so far as the buyer's power to alter things is concerned. The plans of the house may be altered, and the standing house may be changed to suit the taste; but the location of the house is something beyond the control of the buyer. That being the case, the location or site should receive profound consideration; and monetary considerations should give way to considerations of desirability. A few hundred dollars more for the land may mean all the difference between a desirable location and a very undesirable one, and a very salable house and a non-salable house.

Another phase of this land question is the proportion which the cost of the building site bears to that of the house. Only too often the home builder will spend too little on his lot in comparison with the cost of his house. The author knows of one instance in which the home builder spent but \$2,000 on his lot and close on to \$25,000 for his house. The result is that the house is handicapped by its site. It can never be worth the price of the original investment. A house of that value should be in a better locality, or if not, it should at least be surrounded by a large plot. And this case must be typical of many others.

The reverse of this situation is not so serious. If the land is worth far more in proportion than the cost of the house, no great harm is done, except that valuable land is being tied up. However, if the land is worth so much, a time may come when the house must be torn down to make room for a more expensive structure.

Just what proportion the price of the land should bear to the house is a problematical matter. It depends largely upon the prevailing prices asked for land in any one locality. Taken by and large, the average

proportion seems to be anywhere from a quarter to a sixth of the cost of the house, in the case of fully improved land. Thus if the proposed house is to cost \$6,000, it is safe to spend anywhere from \$1,500 to \$1,000 for the land. In these days of high building costs the tendency is to spend as little as \$500 for a lot to accommodate a \$6,000 house, and anywhere from 5 to 10 per cent is considered ample for unimproved lots. Such a policy may make it difficult to secure the necessary mortgages for the proposed building, and this is a question which should be investigated before the land is bought. Indeed, it is well to have an eye for future financing operations when land is being considered.

As for the selection of the building site, it is a matter of individual good judgment. The buyer should beware of misleading advertisements. He should not be led astray by attractive terms and new developments. Only too often lots are purchased in a new development for which all kinds of rash promises are being made, the main attraction being the easy terms, involving but a little cash down and so much a month. Terms of this kind may prove attractive at first, but it should be borne in mind that those very terms also attract others, generally of the poorer and less desirable sort, with the consequence that a person of some refinement finds himself surrounded by very questionable folk in short order. This business of not knowing who one's next door neighbors are going to be in a development of the usual kind, is a serious matter. Not only are the adjoining lots apt to be sold to anybody with little or no restrictions, but then the lots are sold and resold many times before they are finally built upon. Imagine the building of an attractive home on such a lot, only to have a most undesirable family build some sort of a shack alongside! It happens over and over again. Furthermore, many real

estate developments start out with glowing promises and numerous restrictions which seem to promise much for the high character of the community to be. But once the real estate promoter has disposed of all his lots, he has little if any interest left in the development. The original contracts for the sale of lots often bear a clause to the effect that after so many years the restrictions are removed. By all means, give this matter of real estate developments the most serious consideration. Especially should the promoter or promoting company be thoroughly studied as to integrity and honesty of purpose.

Buying a lot in an established community, especially between other standing houses, is generally a safer procedure. At least one knows how the neighborhood will be, because it is already in existence. Furthermore, various improvements, such as sidewalks, streets, sewers, gas, electric light and so on are already installed, and there is no fear of future heavy assessments from this direction. Therefore, a few hundred dollars more at the start may mean all the difference between avoiding heavy assessments and trouble, and knowing your neighbors immediately.

WHAT TO LOOK FOR IN BUYING A BUILDING SITE

Land, so far as the house building question is concerned, takes the form of large parcels or estates or farms, whichever you wish to call them, and plots or lots. Most of us are interested solely in the latter. The former is bought by the acre and is generally unimproved. Hence we confine our present thoughts to the question of lots.

The following fundamental questions should be answered before a person signs any agreement of sale for a building site or a standing house:

- 1.—Is the property high and dry and healthful?

The health of the family comes first, does it not?

2.—What kind of water supply is available? Only too often a person will buy attractive and inexpensive land, only to discover that there is no public water supply and that expensive artesian wells must be sunk.

3.—Are schools, churches and stores convenient? Is the community attractive socially? Is it an expensive place to live in, or is it within the means of the buyer?

4.—Is there a public sewer or must the buyer install a sewage disposal plant? Here again, a public sewer brings up the price of the land, but it saves the buyer the few hundred dollars additional first cost many times over in the course of years.

5.—How far from transportation facilities, and what are the transportation rates to place of employment? By all means study the time tables beforehand.

6.—What is the local tax rate? This is an important question. Only too often the buyer is stunned to learn the taxes which he must meet year after year, along with the other expenses of buying the home.

7.—Are electricity and gas readily available? No home is complete today without electricity. Gas can be dispensed with, but only with some inconvenience. Excellent kerosene and gasoline stoves are available today; but, truth to tell, they do not quite take the place of gas.

8.—What is the topographical nature of the plot? Has it rock which will have to be blasted at a considerable expense? Has it large trees which will have to be uprooted at considerable expense? Does it rise too rapidly or fall too rapidly from the street, necessitating awkward construction or excessive filling-in or expensive terracing? Does the plot require much grading, seeding, or planting?

9.—Is the community progressing, so that the investment involved may be worth more, rather than less, as time goes on?

10.—Is the plot absolutely free and clear of any encumbrances as far as the title is concerned, and is it in a section in which financing facilities are available? Occasionally, the buyer of land is sadly disappointed when he endeavors to obtain building loans or mortgages.

Time should be taken in purchasing a piece of land. The matter should be looked at from every angle. Outside opinion should be sought—and heeded. An appraisal of the property by a building and loan association is generally safe. The judgment of dependable real estate dealers is always worth while. The assessed value of the property, which may be learned by examining the assessment roll of the locality, will give a pretty good idea of the relative value of the property in question, although it should be borne in mind that the assessed valuation is generally but 50 per cent or even less of the actual market value. However, the assessed valuation serves as a guide in determining the true worth of a piece of property.

MAKING THE PURCHASE

In the case of land, there are several ways of making a purchase. The simplest, of course, is to buy for cash. However, few of us are so fortunately fixed as to be in a position to pay spot cash, hence terms must be sought. In this event there are two alternatives: One is to pay down anywhere from 10 to 30 per cent, and to give the seller a mortgage for the balance. The mortgage is generally of the "purchase money" type which means that the buyer of the land must pay a stipulated amount to the mortgagee every so often until the amount of the mortgage is cleared up. In such a case the buyer receives the deed to the property at the very start, although there is a first mortgage on the land which prevents him from raising any appreciable



The gentle art of making over old buildings into new buildings. Here is a long stable shed which, by a few minor changes, has been converted into the attractive building shown on page 35.—(Photo. by the Author.)

sum for the construction of a house. One of the cardinal rules in home building is that the land be free and clear before building operations can be financed by building and loan banks, or mortgage companies.

The other method is to pay a small amount down on a contract which stipulates regular payments until a certain amount is attained, when the purchaser receives the deed to the property. In this instance the first cash payment may be considerably less than when the deal is swung by means of a mortgage, but it is somewhat less satisfactory. Not having the deed to the property, the purchaser has nothing more tangible than a bit of paper termed a contract. If the integrity of the firm or individual with whom the contract is made is beyond reproach, all well and good; but if that firm or individual is of a questionable character and should suddenly go out of business, as too many have been doing in the recent past, then the purchaser stands to lose everything he has paid in.

In the case of a house, the transaction is about the same except that it should be marked by even greater caution. Customs vary in different localities as to the method of arranging a mortgage and completing the purchase of a piece of property. In many places it is common to have a purchase offer or sales contract signed in advance of the actual transfer of the property. In the purchase offer or contract the buyer agrees to pay the holder a certain sum for the property, provided certain conditions are complied with. When this offer is accepted by the owner it can be used as a basis for arranging loans with which to complete the transaction.

If the intended buyer makes a cash deposit with his offer it is particularly important that he should specify in it whether movable property, such as window shades, gas fixtures, stoves, and other items are included, and should state that risk from fire or elements is assumed

by the owner until the title passes. The offer should also be dependent on whether the buyer obtains a satisfactory loan to get the money needed to pay for the property, and on the owner's furnishing papers showing a good marketable title, free from back taxes, liens, encumbrances, or objectionable easements. It is important for a buyer not to bind himself until he is sure exactly what he is to pay for and has made definite financing arrangements. Otherwise he may suffer severe loss. The services of a good lawyer at the time the purchase offer is made is always advisable. The matter is too complicated, too fraught with possibilities of unfortunate misunderstandings, too serious in every way, to be engaged in without legal talent at hand.

EXAMINATION OF THE TITLE

Ownership to a piece of land is established by what is known as the title. This is a legal description of the property, including its exact location with reference to certain fixed land marks and its exact measurements, and a statement of to whom it belongs now and from whom it was obtained. Title to a piece of property passes from one person to another as the land is sold over and over again. Titles are recorded usually at the county seat, and it is possible in this manner to trace back titles to the original land grant, in many instances to pre-Revolutionary days. Titles are traced back to large estates which have been subdivided according to certain specified maps, and then sold in smaller parcels or lots.

One must be certain that the title to a piece of property is good. The validity of a title may be insured by a guarantee company, or its soundness assured by an abstract company or a competent lawyer. In obtaining a loan a bank will insist on some such evi-

dence that the title is good. Some banks and building and loan associations include a title search in the transaction. The buyer should satisfy himself that the boundaries and corners of the lot are legally as represented to him. It is well to have a map made in order to check up the land with the title description.

In connection with the title it is well to note whether there are any easements which might, for instance, grant a right of way to a neighbor, or allow a telephone company to place its poles upon or near the lot, or a water company the right to run its mains across the property.

The title to a piece of property may be obtained in the name of the husband or the wife, or in both names. The latter procedure is more desirable in many ways, if there are no business objections.

METHODS OF HOME FINANCING

There are three methods of home financing: (1) membership in a building and loan association, (2) borrowing on first and second mortgages, and (3) paying on contract. Real difficulty is encountered in financing thousands of potential small home owners to whom the usual financing channels are not available, because they lack established credit, or require loans on terms of repayment that do not attract a lender, or because they have not accumulated sufficient capital to constitute a substantial equity in the home desired.

There are several excellent sources of information regarding the financing, planning, and building of a home. The reader is urged to write to the Superintendent of Documents, Government Printing Office, Washington, D. C., inclosing five cents for a copy of "How to Own Your Home," prepared by John M. Gries and James S. Taylor of the Division of Building and Housing, Bureau of Standards, and from which the



It is difficult to believe that this attractive dwelling was once a stable shed. Yet the proof is to be found by referring back to page 81, which shows the building in its original state.—(Photo by the Author.)

present author has obtained much of the data here given. Also, the bulletins entitled "Financing the Small Home" and "Planning and Designing Small Houses" may be obtained from the National Lumber Manufacturers Association, Washington, D. C.

The man who has enough cash to pay in full for a home has no worries about financing. Most people, however, can pay only part of the price in cash and are obliged to borrow the rest. It must always be remembered that the more cash one can pay down on the house the better.

However, borrowing money to buy a home is no disgrace. On the contrary, it is normal and in many ways desirable. Many families in meeting payments on a loan have learned the habit of saving, and have continued it as a step toward financial independence.

Usually it is desirable for families or individuals desirous of buying a home to have, free from obligation, at least one-fifth, or 20 per cent, of the value of the house and lot in cash. While arrangements often are made for a purchase with less, a larger cash payment helps to insure a loan at a low rate of interest and one that can be comfortably paid off. After the first payment is made, a family or individual should be prepared to devote a certain amount of current savings toward paying off the loan at regular intervals.

Only too often a purchaser of a house undertakes too great a financial burden. It is a simple matter to be coaxed into purchasing a beautiful home with very little cash down, but once the house is being carried one soon learns what the mortgages mean. Interest charges pile up rapidly, and so do other carrying charges such as taxes, coal, upkeep, and so on. All these factors should be borne in mind. Furthermore, the object of home-ownership is not merely to meet the interest on the mortgages. Something should be paid off month by month, or quarterly, or semi-

annually, or even annually, on the mortgages, so in time the mortgages are cleared up and the house belongs to the purchaser. There are entirely too many home owners who merely keep up with their mortgages and make no real attempt to pay anything on the principal.

FIRST MORTGAGES

Obtaining a loan with which to pay the balance between the first cash payment and the total cost of a piece of property is usually a simple matter when the amount paid down amounts to 40 or 50 per cent of the whole purchase price. The problem becomes harder as the proportion to be borrowed grows larger. No matter what loans are required, it is always best for a person without experience in real estate matters to borrow from a responsible loan institution, if only for the benefit of its advice in the matter of the validity of the title, seeing that all back taxes and assessments are paid, that insurance is kept up, that there are no mechanics' liens or other claims against the property, and that the price paid is reasonable and the value of the property is not likely to fall within a few years. The fees charged and services rendered by different institutions in arranging a loan may differ substantially and may more than offset a difference in interest rates. In most cases a loan from a good bank, building and loan association, or insurance company is an assurance that it thinks the proposition sound.

When money is borrowed for the purchase of a home the lender generally requires a mortgage or trust; that gives him the right to have the property sold at auction in case promised payments on the interest or principal of the loan are not made regularly. A first mortgage up to 50 or 60 per cent of the value of the house and lot is considered one of the safest possible

investments, and it should be easy to obtain such a loan from a building and loan association, savings bank, insurance company, trust company, or from some individual—perhaps the seller of the house.

Mortgages are of various kinds. There is the usual mortgage which runs for one, two or three years, or even longer, at 6 per cent or less, as the terms may be. It becomes due at the end of a stipulated period, when the mortgagee may demand his money or may consent to renew the mortgage. Then there is the purchase money mortgage, which not only stipulates the interest charges and the length of time for which it is to run, but also stipulates certain payments on the principal in addition to the interest charges. The purchase money mortgage is sometimes more readily obtainable than a straight mortgage, for the reason that the lender assumes less risk inasmuch as the money invested is steadily being reduced. Then there is the open mortgage, which stipulates the length of time and the rate of interest, but which permits the mortgagor to pay on the principal whenever he feels inclined so to do.

SECOND MORTGAGES

In many cases it will not be possible for the buyer to borrow all the money he requires on a first mortgage, and he may have to borrow additional funds on a second mortgage or note. The holder of the second mortgage takes more risk, consequently rates of interest on second mortgages usually run higher. Bonuses or commissions as much as 10 per cent are sometimes required for placing a second mortgage.

The contractor who builds a house may take such a mortgage himself and expect to sell it at a quarter or a fifth less than its face value. This fact should be borne in mind, and he should charge less for the house

SECTION I.—CASH PAYMENT OF 20 PER CENT OF TOTAL VALUE.

1. Value of house and lot.....	\$3,000	\$4,000	\$5,000	\$6,000	\$7,000	\$8,000	\$9,000	\$10,000
2. Annual income.....	1,200 to 1,800	1,600 to 2,400	2,000 to 3,000	2,400 to 3,600	2,800 to 4,200	3,200 to 4,800	3,600 to 5,400	4,000 to 6,000
3. First cash payment (20 per cent of value).....	600	800	1,000	1,200	1,400	1,600	1,800	2,000
4. Amount of loan.....	2,400	3,200	4,000	4,800	5,600	6,400	7,200	8,000
5. Interest and amortization (12½ per cent of loan).....	300	400	500	600	700	800	900	1,000
6. Estimated taxes, insurance, and upkeep.....	120	160	200	240	280	320	360	400
7. Total annual expenses.....	420	560	700	840	980	1,120	1,260	1,400
8. Savings included in above total (first year).....	150	200	250	300	350	400	450	500
9. Expenses comparable with rent (first year).....	270	360	450	540	630	720	810	900

NOTE.—Assuming an initial cash payment of 20 per cent of the total value, the annual cash outlay (item 7) in this section is about as low as can ordinarily be arranged for the first few years. The financing charge might be cut down later on, when part of the principal of the loan has been paid off, but the whole debt will be canceled in about 12 years if the payments given in the table are continued regularly.

if the buyer can pay cash. Second mortgages are sometimes obtainable from companies which make a specialty of such business, from employers, and from individuals with money to lend.

The lender, if unscrupulous, may encourage the purchase of an expensive piece of property when he is confident the buyer can not meet the payments, so that he can foreclose the mortgage and buy back the property himself at a forced sale, when prices may be low. This is an additional reason for dealing with a responsible institution, which will usually advise against purchase beyond one's means.

Building and loan associations will, in many cases, prove the best means of financing a home, for they are often able to loan as much as 70 to 80 per cent of the real value of a home, which is generally above the limit allowed by law for savings banks and insurance companies. Such a loan, therefore, may avoid the added complications, disadvantages and expenses that may be involved in case both a first and second mortgage are required. Building and loan associations are often especially helpful in providing means of financing during the construction of a new home. They are usually organized with the chief aim of assisting home-buyers and home-builders. Their system of selling shares on which payments must be made weekly or monthly has proved an invaluable aid to hundreds of thousands of future home buyers in accumulating savings and furnishing a sound and helpful scheme for paying off the principal on loans. The officers of these associations, which are to be found in virtually every progressive community, are generally able to give very good advice to home buyers and frequently help them to avoid unwise purchases.

Membership in some form of building and loan association, whenever possible, is a wise step in preparing the way for home ownership. It is usually necessary to

SECTION II.—CASH PAYMENT OF 30 PER CENT OF TOTAL VALUE.

	\$3,000	\$4,000	\$5,000	\$6,000	\$7,000	\$8,000	\$9,000	\$10,000
1. Value of house and lot.....	\$3,000	\$4,000	\$5,000	\$6,000	\$7,000	\$8,000	\$9,000	\$10,000
2. Annual income.....	1,200 to 1,800	1,600 to 2,400	2,000 to 3,000	2,400 to 3,600	2,800 to 4,200	3,200 to 4,800	3,600 to 5,400	4,000 to 6,000
3. First cash payment (30 per cent of value).....	900	1,200	1,500	1,800	2,100	2,400	2,700	3,000
4. Amount of loan.....	2,100	2,800	3,500	4,200	4,900	5,600	6,300	7,000
5. Interest and amortization (12 per cent of loan).....	252	336	420	504	588	672	756	840
6. Estimated taxes, insurance, and upkeep.....	120	160	200	240	280	320	360	400
7. Total annual expenses.....	372	496	620	744	868	992	1,116	1,240
8. Savings included in above total (first year).....	126	168	210	252	294	336	378	420
9. Expenses comparable with rent (first year).....	246	323	410	492	574	656	738	820

Note.—Assuming an initial cash payment of 30 per cent of the total value, the annual cash outlay (item 7) in this section is about as low as can ordinarily be arranged for the first few years. The financing charges might be cut down later on, when part of the principal of the loan has been paid off, but the whole debt will be canceled in about 12 years if the payments given in the table are continued regularly.

be a member of the association for some time, as a share holder, before one can negotiate a loan.

The growth of the building and loan associations speaks well of their integrity and excellent work. In July, 1923, there were 10,009 of these institutions, with a combined membership of 6,864,144, and with assets of \$3,342,530,953.

The cost involved in obtaining a loan from a building and loan association is not uniform with all associations. Some charge the borrower only with actual expenses involved in viewing and appraising the premises, and the drafting and recording of necessary papers. Other associations make a flat charge on all loans to cover the cost and expenses in consummating the loan. Still others charge a certain percentage of the loan to cover the costs. Occasionally, a bonus is charged on all loans in addition to the actual cost incurred. Building and loan associations charge a rate of interest depending upon local money conditions and the vision of those conducting the association. In rapidly growing communities in the West where the demand is heavy, and the supply of funds often meager, mortgage rates are likely to be higher than in the Central and Eastern States where the rate varies from 7 per cent to 6 per cent.

Financing a standing house is considerably easier than financing during building. If the owner retains the title to his land, in the latter instance, and pays the contractor as the work progresses, he may have to make some special arrangement to borrow money before the house is complete. He will, of course, have to pay interest on the sum so borrowed while he is still paying rent elsewhere, and he may consider the interest he pays during the construction period as a part of the first cost of the house. Where a house to be built is to be financed, it is necessary to take the plans of the house and the deed of the land to a build-

SECTION III.—CASH PAYMENT OF 40 PER CENT OF TOTAL VALUE.

	\$3,000 { 1,200 to 1,800 }	\$4,000 1,600 to 2,400	\$5,000 2,000 to 3,000	\$6,000 2,400 to 3,600	\$7,000 2,800 to 4,200	\$8,000 3,200 to 4,800	\$9,000 3,600 to 5,400	\$10,000 4,000 to 6,000
1. Value of house and lot.....								
2. Annual income.....								
3. First cash payment (40 per cent of value).....	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
4. Amount of loan.....	1,800	2,400	3,000	3,600	4,200	4,800	5,400	6,000
5. Interest and amortization (12 per cent of loan).....	216	288	360	432	504	576	648	720
6. Estimated taxes, insurance, and upkeep.....	120	160	200	240	280	320	360	400
7. Total annual expenses.....	336	448	560	672	784	896	1,008	1,120
8. Savings included in above total (first year).....	108	144	180	216	252	288	324	360
9. Expenses comparable with rent (first year).....	228	304	380	456	532	608	684	760

NOTE.—The total outlay (item 7) in this section is based on the assumption that a family able to pay 40 per cent of the value of a home in cash will normally find it best to pay off the loan in installments, at least as rapidly as in the preceding cases.

ing and loan or a mortgage company or bank, and make the necessary loan arrangements. The money for the construction work and materials is generally given to the builder in instalments. So much is paid at a certain point in the construction, so much more at a later point, so much latter on, and so on, until the house is completed. The details vary in different instances and should be discussed and decided upon in advance to avoid misunderstandings.

In some States cases arise where better terms can be made when the title does not pass to the buyer as soon as he occupies the home, but remains with the seller for a few months until the cash payments amount to 25 or 30 per cent of the total value of the property. Agreements under these general circumstances assume a variety of forms. It is especially important that the legal details be sound in every respect and that the integrity of the seller be well established. It is safest to obtain the advice of a lawyer and observe all precautions.

No matter how a home is financed, the mortgages or other indebtedness against it should never be regarded as permanent. Mortgages should be paid off, little by little, in a systematic manner. If there is a shortage of mortgage money when the mortgage falls due, there may be difficulty in renewing it. In the case of second mortgages especially, this is important, and they should be amortized as quickly as possible. The home is never one's own until all the mortgages are cleared up.

PLANNING THE HOME

So much for financing arrangements. Now we come to the question of building the house. The first step in home building is to determine just what kind of home is desired, what one's financial strength really

is, and then secure the necessary plans. These details precede the financial arrangements, but since we have dealt with land and with the purchase of standing houses, we had to follow up with financing details. So we now deal with the problems of getting started with one's home, which originate with an idea and terminate in the finished structure.

Having made up one's mind as to what is desired and required, the financial ability having been carefully analyzed so as not to overstep all bounds of common sense and bring down heaps of trouble and despair over one's head in years to follow, the next move is to secure the plans. Unless the home is to be something decidedly peculiar to one's taste, it is just as well to make use of one of the many excellent stock plans now available. Within recent years there have been ingenious building plans worked out for the small home builder, which have for their object the production of attractive and practical homes at a minimum cost. Thus excellent stock plans are available from the National Lumber Manufacturers Association of Washington, D. C., and individual lumber companies, in the case of frame buildings. Concrete house plans may be obtained from the Portland Cement Association, 111 West Washington Street, Chicago, Ill. The Common Brick Manufacturers' Association of America, Cleveland, Ohio, and the American Face Brick Association, People's Life Bldg., Chicago, have plans for brick houses. Other associations advertise attractive building plans. Various magazines have building plans.

Perhaps the best source of all-round plans for small houses is the Architects' Small House Service Bureau of the United States, Inc., which is controlled by the American Institute of Architects. This Bureau has for its object the supplying of attractive plans for small homes at minimum cost. The national headquar-

ters of this worthy movement on the part of the architectural profession to supply the American public with better houses, has been established at 1200 Second Avenue, South, Minneapolis, Minn., and with regional bureaus located in Denver, Milwaukee, New York, Portland, Indianapolis, and Pittsburgh. Excellent books containing much valuable information on home building, together with numerous sketches and floor plans of houses, are published by the various branches of the bureau and may be obtained at a reasonable cost. The Bureau also publishes an excellent little journal which contains important information for home builders.

The plans for homes, together with the agreement between contractor and owner, quantity survey, and complete specification, are available at anywhere from \$25 to \$50. In view of the importance of securing proper plans so that the proposed home will be a delight rather than a disappointment for lack of architectural treatment, as well as the various details incidental to home building, it is money well spent. Only too often the home builder works with rough plans made by some local carpenter or builder who knows absolutely nothing about architecture aside from putting up some sort of shelter which is to serve as a home.

In the case of the small house, it may not be profitable to employ an architect. But where the home runs up into considerable money, it is well to spend a small proportion of the total expenditure for the services of an architect, not only to draw up the plans, but to supervise the construction of the house. The superintending of the erection of the home forms the most valuable feature of an architect's services. Builders are as honest as any other people, but the point is that the home builder wants to know that he is getting exactly what he is paying for.

CONTRACTS AND EXTRAS

After the plan has been decided upon and prepared or purchased, as the case may be, it is best to start at the beginning and recheck everything to be sure that nothing has been overlooked. This is the time to make the necessary changes in the plans, to introduce little improvements here and there, and otherwise alter one's ideas. It is best to make these on paper, rather than to make them when once the work is under way. The stunning blow delivered by the contractor when he presents the bill for "extras," may be avoided by studying the plans and making all necessary alterations at this time, before signing the contract to build.

In most cities it is necessary to obtain a building permit from the municipal authorities, for which a small fee is charged. The plans must be shown to the authorities to see that they conform to the building code, and the zoning ordinance. The matter of building permit should be looked into as soon as the plans are prepared. In the open country there is seldom necessity for a building permit, but the prospective home-builder should make sure of this point before going ahead.

The contract for the finished house may be placed with a single contractor who will be responsible for the entire job. This is usually the most satisfactory way, for the contractor may be able to secure better terms and supervise the work more effectively than the home builder. Ordinarily a dependable contractor is able to judge the quality of the work better than the owner. When a contract is let to a single contractor on a lump-sum basis, the owner knows at the start what the cost of the house will be, provided his plans are complete and he does not have to allow for extras.

Sometimes, most of the work is let to a general con-

tractor, and separate contracts are made by the owner for the lighting, heating, and plumbing equipments. Occasionally, the owner lets separate contracts for each part of the work and supervises it himself, but this procedure is usually unsatisfactory.

Builders of a home frequently make the mistake of selecting some "very nice man," and assuming that he will build the house at the lowest possible figure. As a rule, it is best to obtain the names of several dependable contractors whose financial standing is good and take bids from these, in order to check against excessive costs. It is not necessary to accept the lowest bid, and it may be well worth while to pay a little more to a contractor who is dependable and has a reputation for good construction work to live up to. But it is not fair to ask bids from a contractor unless it is intended to give his bid reasonable consideration.

There are three main types of contracts that are used in building work:

First: The contractor may be paid a lump sum for the work he undertakes.

Second: The contractor may be paid for all materials and labor, and receive in addition an agreed percentage of their cost.

Third: The contractor may be paid for materials and labor, and a fee for supervision fixed in advance.

The first, or lump-sum basis, has the advantage of settling the cost in advance. The second method does not settle the total cost in advance, and unless it is modified the contractor will profit through increased expenditure for labor and materials.

The contract forms should be drawn up with strict attention to legal requirements and should be fair to both parties. It is advisable that they should provide for arbitration of disputed points before a third party. This insures a quick form of settlement for disputes that might otherwise hold up completion of the con-

tract or lead to court action. The American Institute of Architects issues easily obtainable standard contract documents that satisfy the requirements mentioned.

The signature of both the owner and the contractor should appear not only on the contract but on the specifications and drawings, all of which should be included as a part of the contract. This is most important in case of any disputes, particularly if action in the courts should arise.

Before making the final payment to a contractor, care should be taken to find that all his bills for wages and materials have been paid. If one borrows from a building and loan association, bank, or insurance company its officials will probably help in making sure on this point. In some States lien laws make the owner of the house responsible for all bills. He is the only man having material evidence of having received the benefit of labor and materials. Should the workers or the material dealers not be paid by the contractor the law may give them a preferred claim or lien on the property, and the owner may have to pay a second time for such work or materials as the contractor failed to pay for.

WAYS OF REDUCING THE BUILDING COST

A family always wants in a house a number of things that are not absolutely essential. If funds are limited, it is wise to leave some of the finishing touches until the money is in hand to pay for them. This is sometimes true even when the actual cost with the workmen on the job would be less than it would be later.

1.—It has been estimated that on a five or six room house, \$50 to \$150 may be saved by omitting basement partitions.

2.—A porch may be added at any time, and by leaving it off \$300 to \$600 may be saved at a time when the initial cost is eating into the ready funds.

3.—Stock sizes of doors, moldings, fittings, and sash cost less than special millwork, and there is less waste. There are plenty of good styles in the stock sizes, and the architectural effect is often better than when unusual and unique shapes are used.

4.—Wide siding is more attractive than narrow, but the price at times is about twice as much.

5.—Planting the yard may also be deferred.

6.—The house may be made as small as possible, consistent with taking care of the family for the time being. At some later date the house may be added to, especially if the original design takes this possibility into consideration.

There are many other places where desirable economies may be practiced, but slipshod workmanship or the use of faulty materials should always be avoided, as it is costly in the long run and may necessitate repairs and replacements shortly after the house is completed. It is better to build a smaller house well than to have a larger one badly built.

In the completed house the owner can not determine the quality of certain materials or workmanship. For example, when a house is finished he will not be able to inspect the quality of electric insulation, nor can he see whether or not there has been a proper nailing of studding, and bridging of joists, or if there is good fire stopping. Concealed parts cannot be seen and appraised after the building is erected. In part, the owner will have to rely upon examination of the quantity survey and the work of the building inspector. It is easy to hide poor construction. The studding and the upper floor joists may be of very poor quality of lumber. Brickwork that is covered may conceal poor workmanship as well as defective brick. The

quality of subfloors can not be observed from an inspection of the completed building if the ceiling has been plastered or ceiled. For protection from shoddy work the owner must depend upon the contractor, the architect, if there is one on the job, the building inspector, and his own observation during the period of construction.

MAINTENANCE COSTS AND EXPENSES OF HOME OWNERSHIP

In addition to payments on principal and interest on loans on a home, allowance must be made for some or all of the following expenses: (a) Renewels and repairs, (b) property tax and special assessments, (c) insurance, (d) water tax or rent, (e) accessories, and (f) improvements. In addition to these items, some home owners add in the interest which they would otherwise receive on the amount of their cash payment or equity.

In considering annual expenses, maintenance is often neglected by those who buy new homes. The amounts spent will depend largely on the owner's ability and readiness to be his own repair man. After a few years certain parts of the house will need to be repaired or renewed. The outside sash and trim of all houses and the entire exterior of some will need repainting at intervals. This is an expense which many home buyers do not consider when they buy. The interior walls will need repapering or repainting every few years.

In the purchase of a house it is well to find out the tax rate and the assessed valuation, so that the amount of taxes to be paid each year may be estimated. If the street is to be paved, or new water, sewer or gas mains, or electric light lines are to be put in, there may be special assessments charged against the prop-

erty. It is well to find out which ones of these must be allowed for.

The rate of fire insurance may depend upon the materials used in building, the fire protection afforded in construction, the location of the house, but it is rarely as much as one-half of 1 per cent of the value of the house. Insurance is necessary not only to protect the mortgage holder but also the equity of the owner. It is always required by the bank, trust company, or building association making the loan.

The water tax is usually small but should be considered in estimating fixed expenses.

The purchaser of a new house usually finds that he must spend something extra to make the house comfortable. As a rule he must buy screens for all the windows and some of the doors. In cold climates he frequently finds it advisable to buy storm windows and storm doors, or at least to install weather stripings. Awnings, as a rule, must be purchased by the owner. Frequently \$200 or more must be spent on the house before it is in satisfactory condition.

CHAPTER III.

BUILDING MATERIALS THAT GO TO MAKE THE HOUSE

THE old saying about the weakest link of a chain applies equally well to the house. The materials that enter into the construction of a house determine whether that house will be a good house or a poor house; and, conversely, it follows that a house is no better than the poorest material which enters into its construction.

So it is evident that the builder should not be satisfied with any but the best materials. It is always wiser to build a smaller house or a more modest house, while retaining the best of materials. Only too often a misguided builder will figure on an ambitious plan and then, to make the building costs come within the scope of his pocketbook, he will go to work and employ poor materials and poor workmanship. The error of starting out with poor materials and poor workmanship can never be rectified in the future. Repair may follow repair, and replacement may follow replacement; but the fact remains that a poor house remains fundamentally poor. Pretty architectural treatment, attractive color scheme, beautiful location, large rooms—all these things may produce a handsome house.

Nevertheless, down at the bottom of the whole matter any house comes down to the question of materials and workmanship. Materials first, then workmanship, produce the house. Poor workmanship is more obvious than poor materials, hence the special stress laid on the latter.

LUMBER—THE CARDINAL MATERIAL

There is a mistaken idea abroad that lumber figures mainly in a frame house, and not in a brick, hollow-tile, stone or cement-block house. Nothing could be more erroneous, for it is a fact that lumber is the main material entering into the construction of any type of house short of a fire-proof office building, garage or theatre, where steel framework and concrete floors replace the usual wooden structure. Lumber is the cardinal material in home building. Even the brick or other masonry house makes use of lumber for the inside skeleton, the floors, the roof supports, the stairs, the doors and trim, the windows, and so on. Hence the first consideration is a more or less detailed study of lumber. The author is indebted to Arthur Koehler, expert in wood identification, Forest Products Laboratory, for the data which is incorporated in the following.

First of all, wood is so widely employed because it has certain natural advantages, the foremost of which is the ease with which it can be worked and fastened. Then, too, it has sufficient strength and hardness for general purposes. Again, it is comparatively light in weight. It is a good protection against heat and cold, and it is pleasing in appearance. These properties, which are due to its peculiar chemical nature and physical structure, have made wood unique among building materials.

An impression seems to be prevalent that the supply

of wood is becoming so depleted that in the near future it can be used only for ornamental or special purposes. This is erroneous. We still have enough virgin timber in this country to last for several generations, and with the growing practice of forestry a certain supply will always be maintained, partly by increasing the yield of timber per acre and partly by checking the waste in using the timber. Although the centers of production are being removed farther and farther from the centers of population, freight rates do not make the shipment of lumber across several States prohibitive, wood being a comparatively light material.

STRUCTURE AND CLASSIFICATION OF WOOD

Wood differs in structure from other materials largely used in the construction of the home in that it is composed of cells. These are minute, hollow, elongated tubes, grown together tightly and mostly closed at the ends, although in the hardwoods some are open at the ends to facilitate the conduction of saps. Many of the properties of wood can be attributed to this cellular structure. Since wood is a porous material, it can be cut with greater ease than if it were a homogeneous solid, and nails can be driven into it, thus affording a simple means of shaping and fastening pieces together. The empty cells act as dead air spaces and retard the conduction of heat and sound, thus making wood admirably fitted for building purposes and furniture. Because of its porous nature, preservatives can be forced into the wood, and paint and other finishes will adhere to the surface readily, thus making it possible to prolong the natural life and to increase the beauty of the wood.

In woods grown in a temperate climate the cells formed in the spring of the year are larger than those formed later in the season. This differentiates the sea-

son's growth into springwood and summerwood. The contrast between the summerwood of one year's growth and the springwood of the succeeding year defines the annual rings. These alternating concentric rings or bands of springwood and summerwood are responsible for most of the figure or grain in plain oak, chestnut, cypress, yellow pine, and Douglas fir lumber. In other woods, as birch, gum; yellow poplar, and white pine, there is little difference between the spring wood and summer wood, and the figure is not so pronounced, although some woods, such as maple and gum, may be figured from other causes.

Logs of most species show an inner, darker core—the heartwood—and an outer, lighter layer—the sapwood. This difference in color is not always pronounced, however, for in the spruces, true firs, hemlock, cottonwood, tupelo, basswood, and holly, the heartwood is little, if any, darker than the sapwood. In some woods, especially the pines and red gum, the sapwood is often stained blue by a fungus which lives on the sap in the cells but does not attack the wood sufficiently to weaken it appreciably. This discoloration, which is known as sap stain, is considered a defect only in lumber used for finishing purposes.

The heartwood is usually preferred over the sapwood, either because it is more durable under conditions favorable for decay or because it is more decorative. For certain purposes, however, as interior trim and flooring, the white sapwood of maple, ash, and yellow pine is preferred. Sapwood, as a rule, dries out more quickly and also shrinks less than heartwood; conversely, sapwood absorbs liquids more easily, and, therefore, will take preservative treatment better in most woods, but is not as suitable for liquid containers as is heartwood.

The hardwoods differ essentially from the softwoods in having some cells which have a greater diameter

than others and having open ends, forming continuous tubes extending vertically in the tree trunk. These tubes are known as vessels or pores and are entirely absent in the softwoods. For this reason the hardwoods are also termed porous woods and the softwoods non-porous woods, although the word "porous," taken in the sense of containing small, empty spaces or of being permeable to liquids, would apply to both classes of woods.

HARDWOODS AND SOFTWOODS

The pores can readily be seen with the naked eye in some hardwoods of coarse texture, known as "open-grain" woods—for example, oak, chestnut, and walnut, where they appear as small openings on the smoothly cut end surface or as dark lines or grooves on the longitudinal surface; but in finer-textured hardwoods, known as "close-grain" woods—as maple, yellow poplar, and red gum—these are visible only with the aid of a good hand lens. As a general rule, woods in which the pores can be seen with the naked eye require a filler in finishing in order to produce a smooth surface.

The size and arrangement of the pores, as seen on the smoothly cut end surface, is a valuable aid in distinguishing the different hardwoods. In oak, chestnut, ash, hickory, and elm the pores in the spring wood of each annual ring are comparatively large, forming a distinct porous ring. Such woods are known as ring-porous woods. In other hardwoods, such as birch, beech, maple, basswood, yellow poplar, cotton gum, red gum, and cherry, the pores are of more uniform size throughout the annual ring. Such woods are known as diffuse-porous woods. The size, number, and arrangement of the small pores in the summer wood of ring-porous woods varies greatly, producing characteristic patterns on the end surface of each annual ring. For

instance, in oak and chestnut these small pores are arranged in irregular rows across the annual rings, *i.e.*, tangentially; and in ash and hickory they are few and isolated. It must be borne in mind that in order to see the structure of wood clearly and to the best advantage, in order to identify it or judge its quality, it should be cut smoothly with a sharp knife across the end surface. The cut need not be large—a quarter of an inch square is sufficient—but it must be clean and sharp, leaving no knife marks.

The area between the pores is occupied mostly by wood fibres, which are comparatively thick-walled cells of very small diameter. Usually they are not visible individually except with a compound microscope. The wood fibres serve primarily to give strength to the tree trunk.

Narrow strips of cells known as medullary rays extend radially in the tree—that is, from the bark toward the center—thus facilitating the conduction of sap from the bark to the wood and vice versa. In the oaks some of these rays are very distinct as heavy lines on the end surface. In oak lumber which is cut radially—that is, quarter-sawed—the rays appear on the surface as lighter-colored patches, giving to the finished wood its beautiful figure. Plain oak is cut across the rays, more or less at right angles to them, and does not show these lighter patches or “silver grain.” In sycamore and beech the rays are also very distinct, but not as much so as in oak. Sycamore is occasionally quarter-sawed. In other hardwoods the rays are less distinct, being barely visible, or even invisible without a lens on the end surface and very obscure on the radial surfaces; for example, chestnut, ash, elm, walnut, cottonwood, birch, and cotton gum.

The cells in all the softwoods, on the other hand, are so small that they cannot be seen individually on the end surface without a lens. They are arranged

in uniform radial rows, as seen under a hand lens, which together with the absence of true pores distinguishes the softwoods as a class from the hardwoods. The special name of tracheids has been given to these cells, since they are neither vessels nor true wood fibres, but serve the combined purpose of conducting sap and giving strength to the tree.

In the pines, spruces, larches, and Douglas fir, canals for the conduction of resin extend vertically and radially among the tracheids. These resin ducts, as they are called, are visible in some woods, especially pine, without a lens, but are much less numerous and serve an entirely different purpose than the pores in hardwoods, with which they should not be confused. It follows that other softwoods, as hemlock, the balsam firs, cedars, cypress, and redwood, which have no resin ducts, never show exudation of resin or "pitch" on the surface, even when subjected to heat, as near a radiator or above furnaces. A test for the presence of resin ducts, if not directly visible, is to trim the end surface of a piece of wood fairly smoothly and place it in a warm oven for 5 to 10 minutes. If the resin ducts are present, resin will exude and appear as specks on the end surface to a conspicuous extent in the pines and least in the spruces. The resin ducts often appear as brownish lines on the longitudinal surface of most pines after exposure to the air for some time. This is especially characteristic of sugar pine but occurs in others as well.

While the cedars, junipers, cypress, and redwood do not have resin ducts, they contain an appreciable amount of resin of a different nature, which makes the durability of these woods rank above the average.

IDENTIFICATION OF HARDWOODS

The number of woods commonly used in the con-

struction and furnishing of dwellings is limited, and there is no reason why the housewife or home builder should not be able to distinguish most of them. It is the purpose of the following paragraphs to point out certain characteristics of the more common woods that will aid in their identification. Some woods can be distinguished by their color alone, but in others the color is not distinct enough to permit of accurate description; therefore, the structure is also taken into consideration. It will be repeated here that the hardwoods can be distinguished from the softwoods by the presence of numerous larger cells or pores scattered more or less abundantly throughout the annual ring but not constituting the entire bulk of the wood. These pores should be looked for only on a smoothly cut end surface, and they may not be visible without a hand lens.

The hardwoods start with the oaks, which are commonly divided into two groups in the lumber trade—the white-oak group and the red-oak group. Each group contains a dozen or more botanical species generally not separately distinguished in the market. Where resistance to decay without preservative treatment is essential, the white oaks are more desirable, because they have a greater natural durability than the red oaks; but where strength and beauty of figure only are concerned, the red oaks are equally serviceable.

All oaks are characterized by having very distinct medullary rays and (except evergreen or live oak) in being conspicuously ringporous. The distinction between the white-oak and red-oak groups involves careful examination but is absolutely reliable. In the white oaks the pores in the outer portion of each annual ring are very numerous and very small, thus making it difficult to count them or even see them individually with a good hand lens on a carefully smoothed surface. In the red oaks the pores in the summerwood are larger and less numerous and can be



Sawing Southern yellow pine logs. The clear lumber comes from the outside of the logs, as there are knots near the center. The white bands on the ends of the logs are the sapwood, encircling the darker and more durable heartwood.—(Photo from Scientific American.)

counted easily with the aid of an ordinary magnifying glass. The red oaks usually have a slight reddish hue, and the large pores in the springwood are more open, making the wood appear more porous, but exceptions occur in which this distinction does not hold.

Ash is another ring-porous wood. The pores in the summer-woods are few and small; the rays are not distinct without a lens. The color of the heartwood is grayish brown, the black ash being darker than the white ash.

Chestnut resembles ash superficially. It has a similar color, is decidedly ring-porous, and has inconspicuous rays. The pores in the summerwood are very numerous, however, and arranged in irregular radial rows.

Elm is used comparatively little in the building trades, for it is liable to become rough from wear in the course of time, but its toughness makes it well fitted for bent chair backs, and it is used in other parts of cheap furniture. The wood is light reddish brown in color. Usually the annual rings contain only one row of large pores, but the smaller pores are very numerous and arranged in characteristic wavy bands extending in the same direction as the rings.

Black walnut can usually be recognized by its chocolate-brown color. The pores are scattered promiscuously throughout the annual rings and decrease in size very little toward the end of each year's growth; *i.e.*, the wood is diffuse-porus. The pores are readily visible to the unaided eye, but the rays are indistinct.

Butternut, like black walnut, is diffuse-porous with plainly visible pores. It is lighter colored than the walnut and softer and weaker.

Mahogany has a reddish-brown color, varying greatly in the unstained wood from light to dark shades. The color gradually becomes darker on exposure to the air and light. The wood is diffuse-porous. The pores

are visible without magnification, which distinguishes it from cherry, which is of approximately the same color, and from red gum stained to imitate it. Birch furniture is sometimes so effectively stained that it is difficult to distinguish it from real mahogany, but a small cut which can usually be made in some inconspicuous place will show a white interior, while mahogany is dark throughout. The growth rings of mahogany, which often are very irregular in the same piece, are marked by narrow light-colored lines, which distinguishes American mahogany from the closely related African mahogany, in which these lines are absent. Most other so-called mahoganies, as Philippine mahogany, are no more related to the American species of mahogany than maple is to oak.

Birch lumber is derived mostly from two botanical species—the yellow birch and the sweet or cherry birch, which are very much alike. It is sold as “red” birch and “white” or “yellow” birch, the heartwood of both species being the “red” birch and the sapwood the “white” or “yellow” birch. The heartwood is light to moderately dark reddish brown in color, and the sapwood is almost white. Birch wood has a very uniform texture, the pores being distributed uniformly and the annual rings not conspicuously defined. The pores are barely visible with the unaided eye in good light, thus distinguishing birch from maple, in which the pores are much smaller. The rays, on the other hand, are not distinct in birch but quite conspicuous in maple.

Maple is classed as hard and soft maple. The former is obtained from sugar maple and the latter from the silver maple and the red maple. A good rough test for distinguishing the two groups is by cutting the wood across the grain. The hard maple offers considerable resistance, while the soft maples cut rather easily. “White maple” is sapwood and may be from any species of maple. The chief distinguishing character-

Use.	Red-oak	Hard maple	Soft maple	Oregon maple	Red gum	Birch	Beech	Cherry	Elm	Ash	Yellow poplar	Bass-wood	Cotton-wood	Back-eye	Black walnut	Butternut	Sycamore	Cherry	Mahogany (imported)
House sills.....	X							X											
Beams and girders.....	X							X											
Floors.....	X							X											
Posts.....	X							X											
Joists.....	X							X									X		
Studding.....	X							X									X		
Railroad ties.....	X							X											
Sheds, roof boards, and subfloors.....	X	X			X	X	X	X	X		X	X	X				X		
Shingles and shakes.....								X			X	X	X						
Siding.....						X	X	X			X	X	X						
Exterior trim.....						X	X	X			X	X	X						
Porch columns.....	X					X	X	X			X	X	X		X				
Flooring.....	X	X		X	X	X	X	X	X		X	X	X		X		X	X	
Outside door and window frames.....	X							X	X	X	X	X	X		X	X	X	X	
Doors.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Sash and blinds.....								X											
Interior finish.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Furniture, high grade, ex- posed parts.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Furniture, medium grade, hidden parts.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Furniture, lawn.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Cupboards, cabinets, and re- frigerators.....	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	
Woodenware, as palls, tubs, and kitchen utensils.....		X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	

Soft
woods
have narrow
leaves.

65

[illegible]

istics of the maples are white to pale reddish-brown color, very small pores scattered uniformly, rays as wide as the largest pores, and a thin reddish-brown layer at the end of each annual ring. Oregon maple, as the name indicates, is a western species. It ranks in quality between the eastern hard and soft maples.

Beech is occasionally used as flooring but more often in the hidden parts of furniture. It resembles maple somewhat, but some of the rays are considerably broader and more conspicuous; in fact, they are two or three times as wide as the largest pores and up to one-fourth inch in height, thus giving somewhat of a speckled appearance to the radial surface.

Sycamore can be identified by its conspicuous medullary rays, which are very close together on the end surface and about one-fourth inch high on the radial surface. It resembles beech, except that the rays are more numerous and more conspicuous.

Cherry can usually be identified by its lustrous reddish-brown color. The pores are not distinct without magnification, but the rays are very distinct.

Red gum, or sweet gum, also has a reddish-brown color but is lighter than cherry, often with blackish streaks. It has a very uniform structure. The pores are very small under a lens, and rays and annual rings are barely distinguishable with the unaided eye. On account of the streaks in red gum, it resembles Circassian walnut, but the walnut can be distinguished by the larger pores, visible as dark lines on the longitudinal surface.

Yellow poplar, or tulip poplar, is one of the softer of the hardwoods. It varies from white to light greenish-yellow in color. The texture is very uniform and the grain is straight, which makes it a very desirable wood where strength and hardness are not essential. The pores of yellow poplar are not visible without a lens, but the rays are distinct and the annual rings

are limited by a narrow whitish layer. The sapwood of yellow poplar is sold as "whitewood," but the same name is also applied to basswood and cottonwood.

Cotton gum is a grayish-white wood practically without any figure. The annual rings are indistinct, the pores are very small and evenly distributed and, like the rays, can not be seen without a lens. The wood is without distinct odor or taste and moderately light to moderately heavy in weight.

Cottonwood which, though often called poplar, is entirely distinct from yellow poplar, is found occasionally around the home. It is the wood commonly used for the sides of cracker boxes and light egg cases. In building it is occasionally used for interior trim and siding. Its chief characteristics are light weight, white or pale-gray color, very numerous and uniformly distributed pores, barely visible with the naked eye in good light, and very fine rays.

Basswood is creamy-white in color, rather light and soft, and without figure. Although the rays are distinct to the unaided eye, the pores are exceedingly small. It has a slight odor, which helps to identify it, but for practical purposes it is considered odorless and tasteless.

IDENTIFICATION OF SOFTWOODS

The white pines are a distinct botanical group, with soft, slightly resinous wood of very uniform texture. The white pine of the Northeastern and Lake States, the western or Idaho white pine, and the sugar pine of California are the principal species of this group. Soft grades of western yellow pine, especially the white, narrow-ringed sapwood, are sometimes marketed as "white pine." The wood of the white pine, as a rule, has a creamy-white to light reddish-brown color. The annual rings are marked by narrow, inconspicu-

ous bands of summer wood, thus distinguishing the white pines from the hard or yellow pines, which have wider and denser summer wood. The resin ducts are usually quite distinct as brownish lines on dressed surfaces, especially in sugar pine, and are visible on a smoothly cut end surface as small openings.

The yellow or hard pines as a class are harder, stronger, and more resinous than the white pines, but show great variation in these properties. Some half a dozen species of yellow pine are cut in commercial quantities, but no hard and fast line of distinction can be made between all of these woods. Tests made at the Forest Products Laboratory show the following average weights in pounds per cubic foot of oven-dry wood, based on the volume when green: Western yellow pine, 24 pounds; Norway or red pine, 28 pounds; shortleaf pine (sold as Arkansas soft pine or North Carolina pine) 31 pounds; loblolly pine, 31 pounds; longleaf pine (known as Georgia pine) 34 pounds; and Cuban or slash pine, 36 pounds. These weights are indicative of the relative hardness and strength of these species, but it must be remembered that wood is variable, and some pieces of shortleaf pine are as heavy as the average longleaf pine and some longleaf pine is as light as the heavier grades of Norway pine. The western yellow pine averages about the same in weight as the white pines. As a rule, it contains a very small proportion of the summer wood, which, although it may be very narrow, is always denser and more glistening than in the white pines.

Douglas fir, also known as red spruce, Oregon fir, and Oregon pine, can usually be distinguished by its distinct reddish hue, although the outer parts of old trees are often yellowish. It is a resinous wood, but, on the average, not as much so as the hard pines. Slight exudations of resin are often noticeable, especially on the ends, or can be made to appear by warm-

ing the wood. This test distinguishes Douglas fir from hemlock and redwood, with which it is often associated, but does not distinguish it from the pines or larches, which, however, have more of an orange-brown to russet-brown color.

The larches or tamaracks are heavy, somewhat resinous woods, russet-brown in color. The resin ducts are inconspicuous and difficult to see even under the most favorable conditions. Any indication of resin, however, serves to distinguish the larches from hemlock; the lack of the cherry-red tinge usually is sufficient to distinguish them from Douglas fir; and they are less resinous than the pines, which have distinct resin ducts and are orange to reddish brown in color. The western larch has narrower rings, as a rule, than the eastern tamarack and, therefore, is not as coarse and is more suitable for finish and flooring.

The spruces are important lumber trees, producing light-colored wood of soft, uniform texture. The Sitka spruce of the west coast has a pale reddish hue, but most of the other spruces are almost white, making it impossible to distinguish between heartwood and sapwood, in most cases. The spruces resemble the true firs, except that the former contain resin ducts, although exudations of resin on spruce lumber are rare. Heating the wood, as previously described, may cause sufficient exudation of resin from the resin ducts to make them appear as specks on a smoothly cut end surface.

Hemlock is a non-resinous softwood. Non-resinous as here used means that no exudations of resin normally occur, although more or less resin may be contained in the wood. No sharp color distinction exists between heartwood and sapwood, both being pale brown with reddish tinge. The wood is odorless and tasteless or with a slight soured odor when fresh. The eastern hemlock is coarser, more slivery, and more

subject to shakes—splits along the annual rings—than the western hemlock.

Redwood can usually be identified by its dark reddish-brown color. Dark pieces of western red cedar are sometimes confused with redwood, but can be distinguished by their characteristic cedar odor and slightly bitter taste, the redwood being practically odorless and tasteless.

Cypress varies greatly in color and weight. It is without characteristic taste, but has a somewhat rancid odor which is easy to remember if a person becomes familiar with it. In order to detect the odors in woods, they should be whittled so that fresh surfaces are exposed or, better yet, the sawdust should be held to the nostrils. Other characteristics of cypress are a greasy or waxy surface, most pronounced in the darker grades, and irregular annual rings with a very narrow but dense summer wood.

Northern white cedar is pale brown in color, very soft and light. It has a characteristic cedar odor and somewhat bitter tasting heartwood, which distinguishes it from cypress. The western red cedar is very similar to white cedar in odor and other properties, except that it has a distinct reddish hue.

The true firs, of which there are several species commonly known as balsam fir, white fir, noble fir, and red fir—the latter name is also applied to Douglas fir—are rather light, non-resinous woods. They vary in color from almost white to pale reddish brown, the heartwood being practically of the same color as the sapwood. The noble fir of the West resembles the western hemlocks so closely that it is often impossible to distinguish the two woods when dry except with a compound microscope. In short, the firs have the same general characteristics as the hemlocks, except that they are mostly lighter in color and not as heavy.

The word "grain" is applied in a number of differ-

ent ways in respect to lumber. Wood is said to be "coarse-grained" when the annual rings are wide and conspicuous, and "fine-grained" when the rings are narrow, but woods with very fine pores or cells and indistinct annual rings are always classed as "fine-grained" no matter how wide the rings may be. The painter classes woods with large pores as "open-grained," and hardwoods with small pores and softwoods are classed as "close-grained."

· GRAIN, TEXTURE, AND FIGURE OF WOOD

When the fibres in a piece of lumber run parallel to the surfaces, as can be determined by splitting, it is termed "straight-grained," but when they are not parallel the wood is said to have "diagonal grain" or "cross grain." The latter term is used also when the fibres in the same piece do not all run in the same direction but some slant one way and some another way, thus making it exceedingly hard to split the wood. "Bird's-eye grain" and "curly grain" are due to slight elevations and depressions in the annual rings which appear as smaller or larger circlets or figures when cut through, as in plain sawed wood. "Wavy grain" is due to undulations in the fibres seen best on the radial or "quartered" surfaces. These irregularities in the direction of the fibres cause differences in the reflection of light to the eye, even when smoothly surfaced, and hence produce the beautiful play of figure seen in such woods when tilted back and forth in the light.

"Texture" is often used in place of "grain" when the size and arrangement of the different wood cells are concerned, as "course texture" (oak, chestnut) and "fine texture" (maple and cedars). If there is a decided difference in the hardness of the spring wood and summer wood, the timber is said to have an "un-

even texture" (oak and yellow pine); when there is practically no difference between spring wood and summer wood, the wood is said to have "even texture" (white pine and red gum).

"Figure" is the pattern produced on the surface of a board, whether by the annual rings, cross grain, undulations on the fibres, or irregular colorations.

COMMERCIAL CLASSIFICATION AND MEASUREMENT OF LUMBER

In the market lumber is classified not only according to the kind of tree from which it was cut but also by standard grades (of the same kinds). The grades are determined by the size of the piece and the character of the defects in it. The sizes usually run in standard lengths, widths, and thicknesses. Softwoods are cut into standard lengths of even feet beginning at 4 feet and widths of even inches, beginning at 4 inches, for such material as boards, joists, and timbers, and into lengths of even and odd feet for such material as flooring, siding, and casing. Hardwoods are cut in lengths of even and odd feet, beginning at 4 feet, except for flooring, which may be shorter, and in all widths, beginning at 2 inches, and sold to the nearest inch in width. In general, the lower grades comprise more defective lumber or are narrower and shorter than the upper grades. The standard thickness of lumber is highly variable, depending on the purpose for which it is to be used.

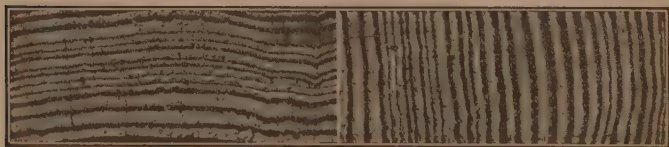
Recognized defects that may occur in lumber are knots, shakes, checks, splits, pitch pockets and streaks, wane, rot, stain, warp, cupping, so-called mineral streaks, pith on the face of the board, wormholes, and the like. In certain woods, where the heartwood is the principal product, sapwood is considered a defect if it comprises over a certain proportion of the

individual piece of lumber. Many grades of lumber are manufactured from each kind of wood, some of which are intended for special purposes, such as the manufacture of doors, wagon boxes, or railway cars. In the construction of dwelling houses the best two grades are commonly used for interior and exterior finish. These grades are variously designated as "clears" and "selects," or "firsts" and "seconds," or "A" and "B," or "No. 1" and "No. 2" for the best and next best quality, respectively, depending on the association which formulated the grading rules. The lumber used for rough construction—as joists, studding, rafters, subfloors, and sheathing—is usually not as good quality as that used for finish. The better grades for rough construction are designated as "No. 1 common" and "No. 2 common." "No. 3 common" and poorer are used only for cheap or temporary construction.

Lumber is sold either by the board foot—*e.g.*, boards, flooring, joists, and studs—or by the lineal foot—*e.g.*, moldings—or by the number of pieces, each piece being of standard size—*e.g.*, lath and shingles. Theoretically, a board-foot contains 144 cubic inches of wood. It may be in the form of a board 1 foot square and 1 inch thick or of other dimensions. In practice, however, the actual dimensions of a piece of lumber are often less than the selling or nominal dimensions. This is due in rough stock to scant manufacture and to shrinkage of the lumber after drying out, and in dressed stock to the custom of basing the nominal dimensions on the size of the rough piece of lumber required to produce the desired finished stock. Thus "2 by 8" hemlock joists surfaced on one side and one edge measure $1\frac{3}{4}$ by $7\frac{3}{4}$ inches, and "2 by 8" yellow-pine joists surfaced on one side and one edge measure $1\frac{5}{8}$ by $7\frac{1}{2}$ inches. This fact should be taken into consideration in figuring the strength of structural ma-

terial and in computing the thickness of walls, floors and other construction where actual measurements are essential. In flooring the difference between actual dimension and nominal dimension is still more pronounced. For instance, a "1 by 3" Douglas fir or oak flooring has a surface width of only $2\frac{1}{4}$ inches and a thickness of $\frac{13}{16}$ inch. This decrease in the width of the surface is necessary in order to produce the "tongue" which fits into the "groove" of the next piece of flooring. The actual thickness of dressed stock is highly variable but practically is always computed as inch material when an inch or less in thickness. The lengths of lumber are full measure.

The most important properties affecting the use of



Two pieces of pine flooring. Left-hand piece is flat sawn or slash grain; right-hand piece is edge or comb-grained. The latter will wear uniformly, while the former will splinter and shell out.—
(Photo from Scientific American.)

wood include: Moisture absorption, shrinking, and swelling; weight or density; thermal and acoustic conductivity; taste and odor; strength; hardness; resistance to decay; and fuel value.

MOISTURE CONTENT AND DRYING OF LUMBER

Green lumber contains a considerable quantity of moisture, a large part of which must be removed before the lumber is put into use. The water in green wood may form from one-fifth to two-thirds of its total weight. The chief reasons for drying lumber

are: To reduce subsequent shrinkage and "working," to make the conditions of decay less favorable, and to reduce the shipping weight. If wood is to be given a preservative treatment, it should also be thoroughly seasoned beforehand.

Lumber is dried either by stacking it so as to be exposed to the air from several months to over a year, or even several years, or by placing it in a dry kiln for several days or weeks. Much lumber is first air-dried and then kiln-dried. When lumber is thoroughly air-dried in the open but protected from rain, it still contains from 12 to 18 per cent of moisture, the percentage being based on its oven-dry weight. Lumber in this condition resists decay fairly well and is fit for such purposes as rough construction, sheathing, siding, studding, subfloors, and other structures in which subsequent shrinkage, if any should take place, would not be a serious factor; in fact, the framework of buildings is often constructed of lumber only partially air-dried. When used in the interior of heated buildings, especially in places where considerable shrinkage would be evident, as in finish, flooring, and furniture, lumber must be dried still more, so that no drying and resultant shrinkage will occur after the wood is in place. Wood used for interiors should contain preferably from 5 to 8 per cent of moisture. If the wood is drier it will swell by absorbing moisture from the atmosphere, thereby causing floors to bulge and doors to stick, and if it contains more moisture it will dry out and open up as soon as the rooms are heated. This is a very important consideration for the home builder, and he should insist that all interior finish, doors, sash, flooring, etc., be made of properly kiln-dried stock.

The moisture content of lumber may be determined with sufficient accuracy by cutting a number of pieces $\frac{1}{4}$ inch in length with the grain, but not at the very ends of boards. These pieces should be carefully

weighed as soon as cut and then placed in an oven heated to about the boiling point of water (212 deg. F) for several hours. If pieces more than $\frac{1}{4}$ inch in length are used, the time of drying must be increased. The pieces are then taken out and weighed. The loss in weight represents the loss in moisture, which, divided by the oven-dry weight and multiplied by 100, gives the per cent of moisture in the lumber. Thus, if the lumber before drying weighed $125\frac{1}{2}$ ounces and after drying 110 ounces, it would have lost $15\frac{1}{2}$ ounces. Dividing $15\frac{1}{2}$ by 110 and multiplying by 100 shows that the wood had slightly over 14 per cent moisture based on the dry weight. This is too high a moisture content for interior work.

MOISTURE ABSORPTION, SHRINKING, AND SWELLING OF Wood

Thoroughly kiln-dried or air-dried wood will absorb moisture from moist objects with which it comes in contact and from the air during damp weather. The moisture enters the cell walls and causes them to expand, thus swelling the whole piece. As the surroundings become drier, this absorbed moisture evaporates and the wood shrinks. This shrinking and swelling of wood is commonly called "working." It can not be overcome entirely, but kiln-drying reduces the capacity of wood to absorb moisture from the air, hence kiln-dried wood will not "work" as much as wood which has not been kiln-dried. The ordinary "working" of lumber is not a serious factor, for allowance is usually made for it in the fitting of drawers, doors, and windows, and joints in furniture are glued together so that they can not open up. It is of great importance, however, to have the lumber thoroughly dried before being put into place, otherwise it will check or pull apart when it finally dries out.

Wood shrinks very little longitudinally, in fact, so little that the shrinkage is negligible for all ordinary construction. The shrinkage is greatest crosswise in the direction of the annual rings; that is, tangentially. The shrinkage across the annual rings—that is, radially—is somewhat less; consequently, quartered-sawed lumber shrinks and swells less than plain-sawed lumber of the same species.

Warping of lumber, after it leaves the pile or dry-kiln, indicates that it was not properly dried or that its location is such that one part absorbs more moisture than another, *e.g.*, near sinks or water pipes that “sweat.”

WEIGHT OF WOOD

Wood used about the household is not usually selected with regard to its weight, although very light or very heavy furniture or utensils would not be as desirable as those of medium weight. The weight of dry lumber indicates the relative strength and hardness of wood. In general, heavy woods are stronger and harder than light pieces, whether of the same kind or different kinds. Light woods, as a rule, shrink and swell less than heavy woods, but there are some notable exceptions. Light woods also conduct less heat than heavy woods under the same conditions.

One of the principal properties that makes wood desirable in the household is its comparatively low heat conductivity. The use of wood for handles, furniture, refrigerators, fireless cookers, floors and walls, is governed largely by the fact that heat passes through it slowly. A marble-topped table or a tile floor in a room not sufficiently heated would be unpleasant to the touch, as would an iron handle on a hot tea-kettle.

The ease with which heat passes through dry wood depends on its density and on the direction of the

grain. Wood conducts from two to three times as much heat with the grain as across it, other conditions being the same.

Heavy woods conduct heat more rapidly than light woods; therefore, for the lining of refrigerators and fireless cookers as light wood as practical should be used. Oak conducts about twice as much heat as spruce under the same conditions. This is due to the fact that in light woods a larger volume is occupied by air spaces than in heavy woods, and air is a poorer conductor of heat than is wood substance. Dead-air spaces in a wall are more effective in retarding the passage of heat than walls of solid wood.

The heat conductivity of wood is much less than that of other structural materials, such as stone, brick, and concrete. Broadly speaking, the conductivity of heat through stone and concrete is from 10 to 30 times as great as through wood across the grain, other conditions being the same.

Wood is a fairly good conductor of sound along the fibre, in which respect it ranks with brick and stone, but across the fibre sound will travel only about one-third as well as with the fibre. Materials of looser construction, as cork and felts, and even air spaces are still poorer conductors of sound and should be used for "deadening" walls and floors.

TASTE AND ODOR OF WOOD

Most of our native woods are without pronounced odor or taste. A few have characteristic odors, but in none of the woods cut into lumber is the odor of such nature as to make the wood unfit for general use. Care must be taken, however, in selecting woods for making food containers, such as refrigerators, cupboards, and shipping boxes, since some foods, especially butter, take up odors readily. Woods of the laurel

family, of which sassafras and California laurel or myrtle are representatives, have a distinct spicy odor and taste. Port Orford cedar of the Pacific coast has a very spicy, resinous odor; other cedars have a more aromatic odor, especially the pencil cedar or juniper. Hemlock has a slightly sour odor, cypress a somewhat rancid odor, and cottonwood a faint, disagreeable odor. Except in cedars and junipers these odors are rarely strong enough to taint food, unless the food is brought in direct contact with the wood, as in butter tubs and butter boxes. Buckets and tanks are sometimes made of cedar, since after they have been in use for some time the wood no longer imparts its characteristic taste to the contents.

STRENGTH OF WOOD AND FACTORS AFFECTING IT

In the construction of a dwelling house the strength of its timbers, joists, and studding is an important consideration. No definite rule can be laid down, however, as to the necessary size of each piece, for this varies with the size of the building, the type of construction, the length of the span, and the distance the supporting members are apart. The selection of proper dimensions is an engineering problem and should be left to a competent architect. A few suggestions, however, may be of value to the owner in inspecting his building or building material.

The strength of structural timbers—whether bending strength, as in joists and rafters; the side-crushing strength, as in sills and the end of joists; or the end-crushing strength, as in studding—is influenced by several factors. The density of the wood, as indicated by its dry weight, is a good indication of its strength. Heavy woods like oak, yellow pine, and Douglas fir are much stronger than lighter woods, as white spruce and white pine. The density of the softwoods, and

also the oaks and other ring-porous hardwoods, can be judged by the percentage of dense summer wood as seen on the smoothly cut end surface. For the softwoods, like yellow pine, tamarack, hemlock, and Douglas fir, the densest wood is usually found in pieces showing neither very slow growth nor very rapid growth. In the southern yellow pines and Douglas fir an average of six rings per inch, with an average of one-third of each ring summer wood, indicates excellent quality so far as strength is concerned. In general, for ring-porous hardwoods, as oak, ash, and chestnut, the wider the rings the stronger the wood. The home builder should be particularly careful that those timbers which have heavy loads to support be not very wide or of extremely narrow-ringed softwoods, or very narrow-ringed hardwoods, unless they are larger than would be necessary for timbers of average rate of growth.

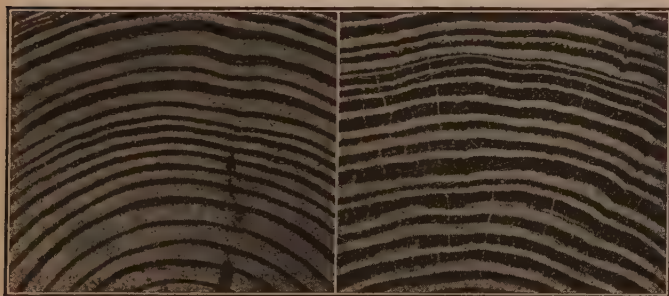
Whether a stick of timber contains much or little sapwood has no direct bearing on the strength. Other things being equal, sapwood is as strong as heartwood. Sapwood, as a rule, is less durable than heartwood, and, consequently, conditions favoring decay, it may soon be destroyed, weakening the structure correspondingly. If the wood is to be given a preservative treatment, sapwood is not objectionable, for it absorbs preservatives more readily than heartwood.

The direction of the grain should be parallel to the sides of a stick in order to afford maximum strength. Diagonal grain greatly reduces the strength of wood. The direction of the grain can easily be determined by trying to split a silver off one or two corners of the stick or by noting the direction of seasoning checks on the longitudinal surfaces.

Moisture in wood reduces its strength, but in timbers the increase in the strength of the wood fibre due to drying is offset by checks and shakes which are the

natural result of seasoning. The influence of moisture on shrinkage and durability is far more important than its influence on strength in the construction of dwelling houses.

The presence of knots and large checks may seriously affect the cross-breaking strength of wood, their seriousness depending on their size and location. Knots in the lower portion of a beam near the middle have considerably more weakening effect than in other portions. Joists with knots on one edge should be placed with the knots up. Knots, provided they are sound, do not seriously weaken the wood in compression. The



Two pieces of pine of the same rate of growth. Right-hand piece is twice as heavy and strong as the left-hand piece, because of the greater proportion of dense wood.—(Photo from Scientific American.)

weakening is least if they are located near the upper or lower edge of a timber and becomes greater as they approach the horizontal plane halfway between the upper and lower edges.

HARDNESS OF WOOD

The hardness of wood governs its wearing qualities in floors and thresholds and its resistance to indenta-

tion when struck by another object. Most of the flooring on the market now has sufficient wearing qualities for all practical purposes in the home, and the choice is between appearances rather than between grades of hardness. It might be said that in "flat grain" or "plain" flooring the surface shows wider strips of soft spring wood alternating with dense summer wood than in "edge grain" or "quartered" flooring, and consequently would show greater tendency to uneven wear. Soft-textured woods, as white pine and yellow poplar, while having certain characteristics which make them desirable for doors and interior trim, are more easily indented by careless handling of furniture than harder woods.

RESISTANCE TO DECAY

The length of time wood will remain free from decay (rot) depends on the conditions under which it is placed and on the kind of wood. Wood will not decay if kept thoroughly air-dry or if thoroughly saturated with water. Specimens have been taken from buildings several hundreds of years old in which the wood showed no signs of deterioration. Similarly, woods taken from the bottom of lakes or from old wells have been found sound after hundreds of years of submergence. Decay takes place most rapidly in wood kept damp and warm.

The sapwood of practically all woods is not desirable and should never be used under conditions favorable for decay. In speaking of the relative durability of woods, the heartwood only should be considered. Woods in which the heartwood can not easily be differentiated from the sapwood, on account of the light color of the heartwood, usually show relatively little durability, although Port Orford cedar is a notable exception. The following lists indicate the relative durability of common woods and should be an aid

to the builder in selecting the more durable species for posts, sills, sidewalks and other structures subject to decay. It must be remembered, however, that woods vary in durability as they do in other properties, and exceptions may be found which, apparently, are not consistent with this classification.

RELATIVE DURABILITY OF COMMON WOODS

(Read down first column, then down second)

Cedar, northern white	Walnut, black
Cedar, western red	Locust, black
Cypress	Cherry, black
Redwood	Oaks, white
Fir, Douglas	Ash, white
Tamarack	Butternut
Larch, western	Gum, red
Pine, longleaf	Poplar, yellow
Pine, eastern white	Oaks, red
Pine, sugar	Basswood
Pine, western white	Beech
Pine, western yellow	Birch
Hemlock, eastern	Buckeye
Hemlock, western	Cottonwood
Pine, loblolly	Elm, white
Pine, Norway	Maple, hard
Pine, shortleaf	Maple, soft
Firs, true	Sycamore
Spruces	Cotton gum
Chestnut	

WOODS USED IN HOME CONSTRUCTION

For the sake of ready reference the author has included in these pages a handy table which shows which woods are commonly used in constructing the various parts of a house and its furnishings. Of course, the species indicated for each purpose are not all equally desirable, and it may be found to be of advantage locally to use other woods. The controlling factors in selecting the kind of wood to be used for any particular purpose are the properties required, whether mainly strength or durability or appearance, or a combination of these and other properties, and the price.

Rough Construction.—The woods used for the framework of dwellings are mostly those kinds that are

fairly abundant and reasonably strong. The softwoods usually fulfill these requirements, the stronger and more durable kinds being most desirable, but others are also taken. In the Central States hardwoods are often used for the framework of buildings. If the sills are in contact with the ground, or the posts are in a damp cellar, or if any part of the frame for other reasons is liable to remain damp, only woods with great natural durability should be selected. Timbers with a large proportion of sapwood should never be used in damp places unless they have been given some treatment to retard decay.

Sheathing, Roof Boards, and Subfloors.—For these purposes the cheaper and more abundant softwoods are usually selected. In certain localities rough hardwood lumber of low grade is used for roof boards, and occasionally even better grades are used for sheathing or subfloors. Durability is not an essential feature, since the lumber thus used is protected from the weather.

Shingles.—Shingles demand a very durable wood because they are usually exposed to the weather without paint covering or preservative treatment. The cedars, cypress, and redwood shingles give excellent results, although pine shingles have been known to last many years. Fresh redwood shingles discolor the rainwater that passes over them and the cedars give it a disagreeable taste, but after several rains leaching ceases and the shingles no longer impart objectionable properties to the soft water for the cistern.

Lath.—Laths are mostly cut from slabs and other waste material and many species contribute to the supply. Coniferous woods are chiefly used, but softer hardwoods are used to some extent. The chief requirements of laths are softness and freedom from warping.

Siding and Exterior Trim.—Comparative freedom

from warping and checking and easy nailing with little splitting, together with fair durability, are the properties especially desirable in woods used for siding and outside finish. Some woods with low resistance to decay, as cottonwood, basswood, cotton gum, buck-eye, and spruce are also used, but special care must be taken to keep such woods well painted and free from moisture to retard decay.

Porch Columns.—Porch columns are of two kinds, solid and built up. Solid columns, if they contain the pith or center of the tree, are very liable to check and split unless they are bored through the center, leaving only an outer shell. Small solid columns should be made of heartwood not containing the pith. Since porch columns are subject to decay, especially at the base, durable woods are highly desirable for their construction. Built-up porch columns give the most satisfactory service, but the lumber should be thoroughly kiln-dried before being put into the columns so that the joints will not open up. The columns should be installed in such a way as to exclude moisture from the interior.

Flooring.—The chief qualities required of flooring are hardness, even wearing, and freedom from slivers. The hardwoods as a class fulfill these requirements better than the softwoods, but owing to the fact that softwoods are cheaper, as a rule, much flooring is made of yellow pine, Douglas fir, and other conifers. Although white pine and spruce are occasionally used for flooring, they are not recommended when subject to considerable wear. Yellow-pine and Douglas-fir flooring is divided into two classes, namely, "flat grain," in which the annual rings are almost parallel with the surface, and "edge grain," in which the annual rings run at right angles, or nearly so, to the surface. "Edge-grain" flooring is more desirable because it wears more evenly and is not as apt to sliver as

the "flat-grain" flooring. Furthermore, the "edge-grain" flooring being quarter-sawn will not shrink and swell as much as the "flat-grain" flooring. Oak flooring is also classed as "plain" and "quartered." In oak, however, the choice is not so dependent on wearing qualities as on the decorative effect produced. Maple is excellent for floors in which hardness and smoothness are desired. Maple has a very compact structure, absorbing liquids slowly, which, together with its hardness and light color, makes it admirably suited for kitchen floors.

Door and Window Frames.—Many woods can be used for this purpose, although a moderate amount of natural durability is desirable, for moisture from the outside may find its way into the hidden parts of frames and produce conditions favorable to decay. This applies especially to the sills of windows. The hardwoods, as a class, are more liable to warp under changes in moisture conditions and, therefore, in general, are not as desirable for this purpose as the softwoods.

Doors.—The choice of wood for doors depends largely on the taste of the builder, the price and finished appearance being the principal considerations. If the doors are to be veneered, the home builder has the choice of many hardwoods and softwoods which are cut into veneer. The cores of veneered doors, and doors which are not veneered, should be made of woods that will not warp and check easily, for often radically different conditions of humidity and temperature exist on the two sides of a door. Soft pine is one of the best woods for veneer cores. The hardwoods as a class, except possibly yellow poplar, are not as desirable for doors (except as veneer covering) as the softwoods, principally because they are more liable to warp, and also because they are heavier and shrink and swell more.

Sash and Blinds.—Sash and blinds require a fairly durable wood that works easily and will not check and warp when exposed to the weather. Yellow-pine sapwood used for sash has been known to rot out in a few years. White-pine heartwood is one of the best woods for this purpose. While soft maple, birch, basswood, and buckeye are used because of their uniform texture and easy working qualities, they are not durable and should be kept well painted wherever used for sash and blinds.

Interior Finish.—A list of woods used for interior finish includes practically all commercial woods. Durability, as a rule, need not be considered, for all interior finish is supposed to have so low a moisture content that decay-producing organisms can not thrive in it. Some of the hardwoods, especially those that are usually cross-grained, as sycamore, cotton gum, and red gum, are liable to warp if not properly dried previously, but when properly dried they make excellent finishing material. The large choice of woods makes possible the selection of finish with pronounced figure, as in quarter-sawed oak and all ring-porous woods and softwoods with dense bands of summerwood; or others with milder figure, as redwood, maple, birch, and mahogany; or others of uniform, fine texture and light color, especially for enameling, as white pine, spruce, yellow poplar, basswood, cotton gum, and buckeye.

Wooden Tanks.—Wooden storage tanks for water are common in dwelling houses. They are usually built up of staves but may be in box form. The woods used must be impervious to liquids and must possess great natural durability. Cedar, cypress, and redwood are specially recommended. If cedar is used, the staves must be allowed to leach for some time if the water is to be used for drinking purposes, because the fresh cedar imparts a taste to liquids in contact with it. Redwood staves will impart a red color to the water

for some time, but eventually this will cease. Dense, resinous yellow pine, the larches, and also the white pines make satisfactory tanks but do not possess as great durability as cypress, redwood, or cedar. White oak is satisfactory but usually too expensive.

CARE AND PRESERVATION OF WOODWORK

Outside woodwork in dwelling houses is subject principally to two forms of deterioration—weathering and decay. The former is by far the least damaging and assumes importance only in regions subject to severe sand storms. The fine particles of sand driven about by the wind wear away the exposed wood to an appreciable extent in the course of time.

Shingles have been known to be worn out by weathering before they suffered seriously from decay, but in such cases they have given service from 25 to 35 years, and such deterioration is not a drawback to their use.

Decay takes place in woods which are fairly moist but not saturated. Dry wood or thoroughly soaked wood will not decay if kept in that condition. Decay in wood is not confined to the outer covering, but it is often more prevalent in the hidden parts which are not exposed to the drying influence of the air. In dwellings decay is most common in posts set on the ground; beams in damp cellars; sills in contact with the soil; the base of porch columns; the backs of window and door frames; the unexposed portion of siding; wood underneath leaks in roofs, drains, water pipes, or around pipes and tanks that "sweat"; and other places where moisture is liable to accumulate, but where it can not readily evaporate.

The chief means of checking decay is to use well-seasoned, durable woods in situations favorable to decay and keep conditions such that they will be as dry as possible. Timbers to be placed in situations where

they cannot dry out, or at most would dry very slowly, should be seasoned thoroughly from one to two years, the time depending on the size of the piece and the climate. Sapwood and nondurable woods in general should never be used in damp places. The making of window sash of sapwood should be condemned. Sills should be kept at least a foot above ground by supporting them on piers or walls of masonry. Posts in cellars should be set on a footing of stone or concrete masonry extending several inches above the floor.

The builder is warned against the use of lumber which has been stored in crowded, unsanitary yards, where the free circulation of air underneath and through the piles of lumber is impossible and where decayed lumber is scattered about the yard. Under such conditions decay may be well started in the wood before it is put into use.

Keeping exterior woodwork well painted, especially the joints where two pieces meet, is an effective means of preventing the rapid absorption of rain and resultant decay, although woods constantly in moist situations will ultimately absorb as much moisture when painted as when unpainted.

The preservative treatment of woods used in dwelling-house construction is not generally practiced because of the expense entailed. Furthermore, creosote, which is one of the best and most commonly used preservatives, has a strong, penetrating odor, usually considered objectionable. It is advisable, however, to apply with a brush two coats of hot coal-tar creosote to the base of posts in cellars and to sills and porch timbers which must be placed in contact with or near to the ground or which for other reasons are liable to become moist. The application of water-soluble preservatives, as zinc chloride and sodium flouride, with a brush, is not sufficiently effective in retarding decay to make it worth while. The more expensive method of dipping

timbers in the preservative or injecting the preservative under pressure is not usually practicable for ordinary dwelling-house construction.

Termites or "white ants" are very destructive to wood in certain sections of the country, especially in the South Atlantic and Gulf States. They live in wood which is in contact with or can be reached from the ground, often completely riddling it with their galleries, leaving only a thin shell. Their ravages can largely be prevented by keeping all wood free from contact with the soil. If this is not practicable, timbers impregnated with creosote should be used. In no case should untreated timber be completely surrounded by masonry, for such conditions prevent the drying of the timber and increases the liability of decay and attack by "white ants."

THE QUESTION OF BRICK

Bricks, which are used so freely in building construction, are made from clays or pulverized shale by three principal methods. They may be made by pressing the soft clay by hand into wooden molds or by means of a machine closely imitating this procedure. This process is called the soft-clay method, because the clay thus molded contains a large percentage of water. The bricks so made are very porous and often cannot be made dense even by hard burning. This, however, does not detract from their durability, as is evidenced by the remarkable resistance to weathering of medieval structures. The texture of soft molded bricks is pleasing and together with the characteristic red color contrasts pleasantly with the green of the landscape. The early colonial residences and churches of Virginia afford many fine examples of architecture in which the building material consists of hand-molded brick.

The second process of brickmaking consists in forcing the clay in a stiff consistency through the die or opening of a machine resembling very closely the ordinary meat or sausage grinder. This machine forms a column of clay the width of which corresponds to the length of the bricks and the thickness to the width. By means of wires stretched between a frame this column is then cut into bricks. The amount of water used in this process is very much less than in the first case, and hence this mode of shaping is called the stiff-clay process. This process is especially used in the case of front bricks, since it can be made to produce a characteristic texture and removes the uniform, machine-made appearance which they would otherwise possess. Bricks so treated are brought on the market under numerous trade names, such as "tapestry," "Devonshire," or "rug" bricks. When the color of the bricks is good, this texture undoubtedly contributes largely towards attaining beautiful effects.

The porosity of bricks made by the stiff-clay process is considerably less than for the soft-molded products, owing to the smaller amount of water used in tempering. Still, in spite of the greater density, it is more essential that stiff-molded bricks be burned hard than it is with the first class. Very porous, underburned stiff-molded bricks are more likely to succumb to frost action than the soft-molded products. At the same time a characteristic structure is produced by the action of the auger of the machine—a kind of twisting, resembling the strands of a rope—which is undesirable if it is excessive. Usually, however, it is not an important factor in such building bricks if they are burned sufficiently hard.

The third process of making bricks consists in grinding the raw material to a moist powder and shaping it into the desired form by means of powerful presses. This method is called the dry-press process.

It results in perfectly shaped and finished bricks, which are compact and dense. In spite of their density they remain quite porous unless burned hard, owing to the fact that the structure consists of the separate clay grains, compacted simply by pressure but still leaving innumerable small pores between the grains. The amount of water used in this process is very small. If, however, the quantity of water is increased and the clay powder made quite moist, the density of the product is increased still more and at the same time the pore space is decreased. This modification is called the semi-dry process and results in the maximum density it is possible to produce. Both the dry and semi-dry pressed bricks were in large demand up to ten years ago, but in recent years the rough-texture stiff-clay products have largely replaced them. The mechanical perfection and finish of the dry-pressed bricks does not appeal to the modern architect, who objects to their smooth regularity and prefers the rough texture and variety of the other kinds of brick.

DURABILITY OF BRICKS

The bricks, after having been molded by any process, must be carefully dried to expel the water and, finally, must be subjected to the action of the fire in kilns. According to the kind of clay many colors and shades may be produced. Owing to the unavoidable difference in temperature in different parts of a kiln, some bricks remain softer and more porous than others.

The quality of building bricks must be considered from several standpoints. It must be kept in mind that the requirements are necessarily more severe in the case of front bricks than for the cheaper kind used for backing up in the wall. For the latter purpose comparatively soft and porous bricks, which would not be suitable for exposure to weather, may be used.

The question of the weather and frost resistance of facing bricks is obviously the most important one. Fortunately it is a quality quite easy to estimate by the most simple means. A well-burned brick when struck with a hammer should give a clear sound, not deadened by soft burning, cracks, or weak structure. A little practice will enable anyone to judge the soundness of the bricks quite satisfactorily. The water absorption likewise may be used as a rough criterion of the quality of the bricks. This test is made in a very simple way, by drying a whole or half brick in an oven, weighing it on a scale, boiling it in water for five hours, allowing it to remain in the water until the latter has cooled to the temperature of the air, and then weighing it again. The absorption of water is then easily calculated by subtracting the weight of the dry brick from the wet brick, dividing this difference by the dry weight, and multiplying the result by 100. This will give the percentage of water absorption. For good facing bricks molded from soft clay the absorption should not exceed 15 per cent and for stiff-molded or dry-pressed bricks the same value should not greatly exceed 10 per cent. This, however, is not a hard-and-fast rule, as some clays, very high in sand or in carbonate of lime, may show higher absorptions and still produce durable bricks. It does, however, cover the majority of the materials of the country, with the exception of some southern and several northern districts. In any case the allowable leeway from the above values should not be more than 3 per cent.

Sometimes very impervious and hard bricks are specified under the term "vitrified bricks." Such materials are, of course, exceedingly durable and are destined to last for generations. All bricks bought as "vitrified" should show an absorption of not more than 4 per cent. Products of this kind bring a higher price on the market and they are worth it. Although the

term "vitrification" in its dictionary meaning implies the idea of glassiness, it is ordinarily employed to indicate that the clay has reached a state of great density and imperviousness. The structure, while it may sometimes appear glassy, is usually more of a stony character. It is interesting to reflect how thus, by the agency of heat, the soft clay is again converted into an igneous stone, similar to some of the old plutonic rocks.

If doubt exists as to whether a brick is really weather resistant, a simple but drastic test can be used to determine its durability. This consists in first preparing a concentrated solution of Glauber's salt (sodium sulphate), which may be bought quite cheaply from any druggist. Such a solution is readily made by filling a pail with water at room temperature and placing in it a sufficient amount of the salt so that after standing several hours, with occasional vigorous stirring, a certain amount of it still remains undissolved. Thus a saturated solution is obtained.

Several half bricks are now dried by heating in an oven at a temperature of over 212 deg. F. for several hours and are then immersed in the solution for 12 hours or longer. They are then removed and again dried in the oven, the temperature of which is brought up to about the temperature required in the baking of bread. This drying requires several hours. If the bricks are still uninjured, they are put back into the Glauber's salt solution and allowed to remain there again for 12 hours longer. After this time they are dried once more in the oven. If necessary this treatment should be repeated until it has been done five times. If the brick is still intact, showing no cracks or crumbling, it may with certainty be considered of good durability and frost resistance. A brick of weak structure will often go to pieces completely or break down to a crumbly mass. This test is very severe, in fact, excessively so, but it errs on the safe side as far

as the builder is concerned. It should, of course, not be employed for common or backing-up bricks, but only to those which are to be used as facing material. The test is really a kind of freezing, inasmuch as the dissolved Glauber's salt is absorbed with the liquid into the pores of the bricks and, upon drying out, crystallizes in the interior and at the same time exerts a considerable force tending to disrupt the body. Bricks which are underburned or are inherently weak will break down under this action.

The mechanical strength of bricks can, of course, be determined directly in the laboratory by means of the crushing and transverse tests, but this does not concern the average home builder. It might be said that no bricks, even those used for backing up, should possess a crushing strength below 2,000 pounds per square inch, not because this resistance is actually needed, but because the strength is indicative of the desired quality. Well-burned bricks require as high a pressure as 25,000 pounds per square inch to crush them.

THE COLOR OF BRICKS

For the paving of driveways, hard, vitrified bricks should be employed, laid on a concrete foundation and well grouted with cement mortar. For foundation walls as hard bricks as can be secured should be used, even though their cost is somewhat higher than that of the ordinary run of kiln product. This will insure not only resistance to the destructive effects of the earth but will also prevent the rise of moisture from the ground to the walls of the house. The practice of using soft-burned bricks for chimneys is also very objectionable, as it has been found that the fire gases exert a very destructive action upon underfired material. Well-burned bricks should be used for this purpose.

The color of bricks may vary from pale to dark red and black or from a cream color to buff and brown. The kind of clay used naturally governs the color obtained, though even with the same clay different colors may be produced. Thus, most red-burning materials will give a dark red when well burned and black when burned very hard. Underburned bricks will usually show a pink or salmon color. Ordinarily buff-burning clays, such as are found in New Jersey, Pennsylvania, Ohio, Indiana and Illinois, may by very hard burning and smoky firing be made to yield browns and golden shades, speckled with dark spots. Uniformity in color is no longer desired in front bricks, but within certain limits variation is demanded to give a lively appearance to the walls, especially where rough textures are employed.

Some red bricks, unless they are burned very hard, show occasionally in service a very disagreeable white surface discoloration, called "white wash" (calcium sulphate). This annoying difficulty usually appears when the bricks are laid up in the wall and in very many cases is due to the mortar especially when the mortar contains cement. If it is due to the bricks, it may usually be traced to its source by placing a brick on edge in a pan containing about an inch of pure water, either distilled or rain water. As the brick absorbs the water, it will develop the white discolorations on the top surface after several days if it contains the soluble salts which give rise to the difficulty. Very hard-burned bricks will not discolor under any circumstances. Sometimes bricks show a slight discoloration which is produced either in the drying or in the kiln. Such defects are permanent and, of course, readily seen before the bricks are used. The trouble of "white washing" may be entirely overcome by adding to clays subject to it a certain amount of barium carbonate. Owing to the comparatively high cost of

this chemical, products so treated command a higher price but at the same time they offer assurance that the discoloration will not appear. Fortunately, in most cases the "white wash" will disappear in time, being washed away by the rains. This is especially true in the case of the white discoloration which appears when salt is mixed with the mortar, a practice which is employed in the winter time to prevent the freezing of the mortar. The most common "white washing," that due to the mortar, is more difficult to combat. It may be reduced by waterproofing the joints around the window sills and between the foundation and the walls so that the absorption of moisture from rain and from its rise from the ground is greatly diminished. The addition of about 2 per cent of barium carbonate to the cement tends to fix the soluble salts contained in the latter and to render them insoluble, thus tending to remove this cause of discoloration. Where the white efflorescence does appear, it may usually be removed by washing the wall with rain water containing a slight amount of muriatic (hydrochloric) acid and following this by washing again with clean rain water.

THE QUESTION OF HOLLOW TILES

The use of hollow tiles for walls, either alone or in combination with a brick veneer, is growing rapidly in the favor of the building public. These tiles are being used both for bearing and non-bearing walls. In the case of the latter, represented principally by partition walls, hollow bricks also are frequently employed. For the former purpose none but hard-burned tile can be considered, while soft material is well suited for partitions. The tiles for outside walls should be true and straight and free from objectionable cracks and should be well burned, so that they do not absorb more than

10 per cent of their weight of water in the absorption test. No hollow tile should contain any void whose cross section, measured at right angles to the web, is more than 4 inches, and the vertical webs and shells of all tiles used for bearing walls should have a thickness of not less than 15 per cent of the measurements across the void inclosed by such shells or webs.

For a one-story building the thickness of the wall should be not less than 6 inches, for a two-story building 8 and 6 inches, for a three-story building 8, and beyond the second story, 6 inches. The laying of tiles with vertical webs is greatly facilitated by the use of strips of wire screen on which the mortar is spread. The use of hollow tile either alone or in conjunction with bricks makes a very desirable residence construction, since the air spaces thus provided reduce very largely any dampness of walls and at the same time cause the house to be warmer in the winter and cooler in the summer. The combination of bricks for facing and tiles for backing up results in the most satisfactory construction and satisfies the esthetic taste, since it makes possible the use of the texture and color effects obtainable with bricks. Such effects can not be got with tiles, which usually require a stucco finish.

Where the considerations of permanency and durability, minimum cost of maintenance, fire and vermin proof qualities, and beauty are given prominence, an all-clay construction is bound to be the most satisfactory in the end. The cost of bricks and tiles in most localities is not high and is not nearly as important an item as is the cost of laying. Tiles are laid up somewhat more cheaply than bricks.

THE POSSIBILITIES OF TERRA COTTA

The use of plain or enameled decorative terra cotta, such as is used in the construction of skyscrapers and

other large structures, has been applied to residence only to a small extent. This is due to the fact that the cost of such work seems high at the present time, in spite of the fact that in large structures terra cotta is furnished at remarkably low figures per square foot of surface. In terra-cotta buildings the designs and finish are nearly always original, at least to a large extent, and the plaster molds used in shaping the ware are destroyed after the completion of each job. If architects would co-operate with the manufacturers of terra cotta in standardizing a series of shapes and designs, it might be quite possible to employ this beautiful building material in residence construction and at the same time secure the variation which is desirable. The problems of design and color treatment are those of a skilful architect, and the subject must be handled with care in order to avoid inharmonious and "dowdy" effects. Terra cotta is essentially a kind of heavy tile provided with a ribbed web which can be inserted and fastened into the wall. The surface is either flat or decorated in relief and may be given any desired color, glaze, or enamel. The main essentials are hard burning and a surface not subject to attack by atmospheric agencies. The water absorption of the terra-cotta body should be not over 12 per cent. Diluted muriatic acid applied on the surface of the enamel should not cause any visible destruction, indicated by roughing, and should bring about no whitish discoloration, which indicates dissolution of the coating. A piece of the terra cotta when tested with the Glauber's solution as described previously, should stand up without showing any signs of breaking down.

WALL TILES AND FLOOR TILES

Tiles, which are essentially thin-walled flat pieces of

burned clay of various shapes, may be used in residence construction for many purposes, such as mantel decoration, flooring (especially for bath rooms) for walls, and as a roofing material.

Under the heading of wall tiles come the well-known glazed tiles used in mantels and bathroom and kitchen walls. These are now made in a large variety of colors and textures, both glassy and matt. They afford an ideal aseptic surface, easily cleaned, durable, and resistant to the action of cleaning solutions. The main consideration in this connection is the quality of the glaze. It should be free from the fine hair cracks known as crazing and should have no tendency to show this defect, which sometimes develops after the tiles have been placed in position. This property may be tested by placing several tiles in a concentrated solution of common salt and boiling for three hours. The tiles should be removed from the solution while hot and then cooled. No cracking of the surface should be observed after several days.

Two kinds of floor tiles may be employed—the vitreous kind, which is very hard and practically non-absorbent and is frequently used in the form of mosaics, and the semi-vitreous kind, usually put down in the form of larger tiles. The second class of tile is often made from a red-burning clay and is then known as quarry tile, which, with its pleasing deep-red color, lends itself so well to producing a decorative flooring which is agreeable to walk on. Where cleanness and aseptic qualities are essential, the first kind of tile is the only one to be considered. The water absorption of these vitreous tiles should not exceed 0.5 per cent and that of the quarry tiles 8 per cent.

The products of the roofing tile class should possess first of all the requisite of weather-resisting properties, tiles should possess a clean color and should show no

tendency to "whitewash" a point upon which a guarantee should be exacted from the manufacturer.

CONCRETE AS A BUILDING MATERIAL

Years of experimental work preceded the adoption of cement as a general building material. Architects will not use a material freely until it has passed the test of time and has absolutely proven its merit.

Probably the most potent factor in bringing about the general use of cement for house construction was its absolute fireproofness. The importance of having a dwelling fireproof is readily appreciated when it is considered that the loss by fire in the United States exceeds \$243,000,000 annually, or about 26.5 per cent of the value of all new construction. In suburban sections where fire-fighting apparatus is often inadequate, fireproof construction offers the only means of safety to life and property. Cities are rapidly adopting regulations that prohibit the more inflammable types of construction.

The present-day builders build for permanence. Service through the years depends upon the materials used. The many extraordinary tests that cement construction has been called upon to withstand have proved beyond question its ability to resist wind, flood and fire. And instead of deteriorating with age, cement improves by growing stronger and harder every year.

The many points of superiority in cement houses may lead some people to believe that the building cost is high compared with other kinds of construction. But the materials used in cement construction have not advanced as much in cost as most building materials. Sand and stone, which constitute the bulk of cement construction, are usually obtainable locally or

at least are not transported from a great distance.

There are many different types of cement construction, which will be dealt at length in the chapter on concrete houses. Suffice it to state here, when we are interested in concrete as a building material, that cement is obtainable in the form of powder which, when mixed with water to a stiff paste, becomes a solid mass within ten hours. It thereafter hardens slowly and gains in strength for an indefinite period, usually attaining its maximum strength after about one year. When mixed with sand and water, it forms a mortar which also becomes very hard and durable, the strength of such mortar diminishing as the proportion of sand is increased. A cube of cement mortar composed of 1 part by volume of cement to 3 parts of sand one month after molding should bear a load of 1 ton or more per square inch. Thus a cylindrical column 8 inches in diameter made from such mortar (usually written "1 : 3 cement mortar") will support a weight of 100,000 pounds without crushing.

In massive work, such as the example last cited, economy is attained without much sacrifice in strength by mixing gravel or broken stone in the mortar. A mixture of this type is called concrete, in which form a very large proportion of all the cement manufactured is used. A very good average grade of concrete for foundations of plain mass work is obtained by the use of 1 part by volume of cement, $2\frac{1}{2}$ parts of sand, and 5 parts of gravel or broken stone, the latter running up to about 2 inches in size for the largest pieces. Concrete made in these proportions is usually expressed as "1 : $2\frac{1}{2}$: 5 concrete," the succession of numbers indicating the proportions of cement, sand, and stone, respectively. A somewhat richer, denser, and more nearly waterproof concrete is obtained by using the proportions 1 : 2 : 4, this mixture being commonly used in the construction of basement floors and walls,

retaining walls, reservoirs, etc. Concrete in the proportions of 1 : $1\frac{1}{2}$: 3, because of its still greater density and hardness, is generally recommended for the construction of roadways. This type of road if properly laid is one of the best for general traffic.

Theoretically, mortar and concrete depend for their strength upon the adhesive quality or bond of the cement to the particles of sand and stone. As the sand and stone are in themselves stronger than the cement, it follows that the strongest mortar should be that in which just enough cement is used to coat the sand grains and fill the spaces between them, and, similarly, the strongest concrete should be that in which just enough mortar is used to coat the stones and fill the spaces between them. In practical concrete work perfect coating of the sand and stone and complete filling of the spaces with the theoretical amount of cement is impossible, and, therefore, the use of more cement yields stronger concrete. It is, nevertheless, true that the making of good concrete requires very thorough mixing, as well as clean sand and stone. The amount of water used in mixing concrete materials is not generally specified, but not more should be used than will enable the mixture to be handled readily and worked into place without leaving pockets and voids. The use of excess water in mixing the concrete may cause a reduction of 50 per cent or more in strength and make it less durable. Therefore, it is important that too much water should not be used.

Concrete is a material high in compressive strength but low in tensile strength and is, therefore, unsuited in itself for the construction of such members as load-carrying beams and floor slabs, which are, as a rule, supported only at their ends. To overcome this defect, the concrete in such construction is cast around steel rods, to which the cement bonds firmly and which, therefore, becomes an integral part of the beam

or slab. The steel supplies the tensile strength which is lacking in the concrete, and the combination, which is ordinarily called reinforced concrete, is suited for almost any type of construction in which strength and rigidity are essential.

Cement dwelling construction calls for the cement proper, which is mixed on the job with sand and gravel and stones to form mortar or concrete, as the case may be, or for concrete blocks and other molded products. Concrete blocks offered a convenient form of house construction. They effect a saving in lumber, as contrasted with the poured or molded type of construction, since all the blocks are cast in the same form. This type of construction also gives the builder an opportunity to inspect each unit. The blocks may be made on the job by using a suitable cement block machine, or they may be purchased from a local maker of such blocks. In building with cement blocks it is better to use molds that give simple finishes. If the blocks are made to imitate stone the house becomes a mass of monotonous units, casting the same shadows and giving a general effect that is anything but artistic or pleasing. Cement construction as such presents a most attractive appearance, but as an imitation of stone or some other material it loses its own individuality and gains nothing. Through the use of attractive stucco finishes over the cement blocks, it is now possible to obtain exceedingly attractive cement houses, which cannot be told apart from hollow-tile construction in general appearance.

SOME FACTS CONCERNING LIME

Another widely used material in building construction is lime. Limestone is one of our best-known and most widely distributed rocks. In a pure state it consists essentially of calcium carbonate. There is,

however, an important variety known as dolomite, in which nearly half of the calcium is replaced by magnesium. Lime is generally defined as the product obtained by the heating or calcination of limestone until the carbonates are decomposed. The carbon dioxide is driven off as a gas, leaving calcium and magnesium oxides in the form of lime. Of course all limestones contain more or less impurities, such as sand and clay, which remain in the lime and if sufficient in quantity may impair its quality. Fortunately, this defect is easy to detect, because a lime containing too many impurities will not slake when added to water.

Lime as defined above is commonly known as quicklime, in contradistinction to the rather loose use of the word to include a number of allied materials. When given an opportunity, quicklime absorbs water and carbon dioxide with great avidity. The calcium oxide in the lime enters into chemical combination with water to form calcium hydroxide. This is the reaction which takes place when lime is slaked. If there is an excess of water present, the resultant product will be a lime paste or putty. If, however, there is just enough water to complete the chemical reaction, the calcium hydroxide produced will be in the form of a dry, flour-like powder, which is known commercially as hydrated lime. Air always contains more or less water and carbon dioxide. When quicklime is exposed to the air, it absorbs both of these substances. The resultant product, known as air-slaked lime, is therefore a mixture of calcium hydroxide and calcium carbonate, the proportions of each ingredient depending largely upon the age of the same. Air-slaked lime may thus be regarded as an intermediate product between hydrated lime (calcium hydroxide) and ground limestone (calcium carbonate).

The four products just enumerated cover the field to

be considered in the following. In addition, these allied materials should be noted:

Dimension stone is stone cut to dimensions for building purposes; it may be limestone, sandstone, granite, etc. Marble differs geologically but not chemically from limestone or dolomite. Cave onyx is the familiar form of calcium carbonate found as stalactites in caves. Chalk, coral, and marl are other forms of calcium carbonate. Rubble or riprap is crushed stone of large size used for filling retaining walls, piers, etc., generally without mortar. Crushed stone of various sizes is used for making roads, as an aggregate for concrete, as a filler for asphalt, as roofing gravel, etc. Especially pure and finely divided forms of limestone are known as "whiting" and "precipitated chalk." Glazier's putty is made by mixing whiting with linseed oil.

Some obsolescent and colloquial terms are apt to cause confusion in the lime industry, and an attempt is hereby made to discourage their use. Among them may be included "stone lime," meaning lime burned from limestone and retaining the original form of the pieces of stone. The material is quicklime; the particular form which it has can make no difference to the purchaser. If it should be desired to have the quicklime in this particular form, the term "lump lime" is more widely used and less apt to be confused with limestones. "Shell lime" is produced from oyster shells either by grinding or by calcining. In the former case the product is simply calcium carbonate, not lime, while in the latter case it is merely quicklime made from shells. This latter fact is of interest to the purchaser only because lime made from shells is generally more impure than that made from stone. "Marl lime" is marl which has been dried but not calcined. It, therefore, consists essentially of calcium carbonate and has no right to the name lime. "Ground lime"

is a prolific source of confusion. In some localities it means ground (*i. e.*, *pulverized*) quicklime. In other places it means any form of lime which can be applied to the ground as fertilizer. In this sense it includes all forms of oxide, hydroxide, and carbonate of calcium, and even the sulphate as gypsum or land plaster.

QUICKLIME

Quicklime is generally delivered in lumps just as it comes from the kiln. For special purposes it may be pulverized to any desired degree of fineness. The ordinary package is a wooden barrel containing about 180 pounds net. Of course, these barrels are not air-tight, so that if lime has been stored in them for some time it is apt to be more or less air-slaked. Air-slaking is accompanied by disintegration of the lumps, so that a barrel which contains very much finer material is open to suspicion. It should not be condemned hastily, however, for some manufacturers are compelled to break the lumps in order to get the required weight into the barrel. To test the quality, take some of the fine material and mix it with about its own weight of water. If it slakes and generates a considerable amount of heat, it is pulverized quicklime and is not badly air-slaked.

Particular care must be observed in storing quicklime. It must be kept in a receptacle which is perfectly tight to both air and water in order to prevent air slaking. If it does come in contact with water, the heat generated is quite apt to be sufficient to set fire to wood. The only way it can be stored safely and satisfactorily is in a metal bin or can with an air-tight cover.

HYDRATED LIME

Hydrated lime is a fine white powder which comes

packed in paper bags holding 40 or 50 pounds. It is able to absorb carbon dioxide from the air, especially when damp. But it has the ability to protect itself from air slaking, since it is a fine powder and the surface becomes coated with a crust of air-slaked lime, which acts as a preservative coating to protect the inside of the mass. To determine whether or not a sample of hydrated lime is badly air-slaked, mix some of it with enough water to form a cream and add some dilute muriatic (hydrochloric) acid. Hydrated lime will dissolve quietly, but the calcium carbonate contained in air-slaked lime will show an effervescence as the carbon dioxide is driven off. The calcium oxide in hydrated lime has all been satisfied with water, so that when hydrated lime is wet there is no possibility of any further chemical reaction, with its attendant evolution of heat. Consequently, hydrated lime may be stored indefinitely in paper bags without any danger of fire. It is quite permissible to store it in the ordinary package, provided ordinary precautions are taken to keep it dry.

When calcium hydroxide is made into a paste with water and exposed to the action of air, first some of the excess water evaporates and then the calcium hydroxide is attacked by carbon dioxide to form calcium carbonate, with the evolution of more water. This process constitutes the setting or hardening of lime mortar. Obviously, it is immaterial, so far as the chemical reaction is concerned, whether the calcium hydroxide is prepared from calcium oxide (quicklime) by slaking or it is purchased as such (hydrated lime). In other words, quicklime or hydrated lime may be used interchangeably with identical results. When building a house, where large quantities of lime are required, economic conditions may be such as to demand the use of quicklime in preference to hydrate. But for ordinary household purposes (ex-

cept in some special cases as a fertilizer or disinfectant) hydrated lime is far preferable for the following reasons: It comes in a smaller package, and if the entire quantity is not used the remainder may be stored in the original package without extraordinary precautions against deterioration and with absolutely no danger from fire. It does not require any preparation for use.

AIR-SLAKED LIME

Air-slaked lime can hardly be considered a commercial product. It can occasionally be obtained in small quantities from dealers who have had quicklime spoil on their hands inadvertently. There is no purpose for which air-slaked lime is used which could not be better accomplished by either hydrated lime or ground limestone. The only advantage of air-slaked lime is its extreme cheapness. Air-slaked lime must, therefore, be regarded as a product which is partially spoiled and which is bought only because it is cheap. Tests for its purity are, therefore, unnecessary. It may, however, contain a considerable amount of calcium oxide, so that storage conditions should be such as to preclude the danger of fire.

MORTAR

Lime has been used for thousands of years in mortar for masonry. Lime mortar is not so strong as mortar made from Portland cement, but its strength is amply sufficient for all ordinary construction. A lime mortar consists of three essential ingredients—calcium hydroxide, water, and sand. If quicklime is purchased, the calcium hydroxide must be prepared from this by slaking. Contrary to the common opinion, the proper slaking of lime is not a simple operation for inexperi-

enced labor. Skilled and experienced labor should be used for this work. The best results can be obtained if the slaking is carried out according to the following directions:

Support the mortar box in such a way that one end is a few inches higher than the other. In the lower end put some water and have a hose handy to add more as needed. Put the lime in the upper end of the box, and work it into the water with a hoe. First add to the water about an equal bulk of lime, and let it alone until the chemical reaction has commenced. This may take from a few seconds to an hour or more, depending upon the magnesia content of the lime and the temperature at which it was burned. When the slaking is well under way, the lumps will have disintegrated and the mass will be quite hot. Stir vigorously with the hoe from now on to prevent local overheating and to ensure an even temperature throughout the mass. The water should be kept continuously at or near the boiling point. If the mass gets too hot, add more water; if too cold, add more lime.

If the temperature drops much below the boiling point, the lime will be "drowned," which will result in a smaller yield of paste and impair its plasticity. If the mass gets so hot that it dries out locally, the lime will be "burned" and will be unsafe to use unless soaked under water for some time. When slaking has been completed with proper care so that the lime is not "burned," the paste should be covered with sand to protect it from the air and allowed to cool. It is better, however, to cover the paste with water and let it age for a week or two. If hydrated lime is purchased instead of quicklime, it is necessary only to mix it with water until a paste of desired consistency is obtained. It is better to add the hydrated lime to the water rather than vice versa, and greater plasticity can be obtained by soaking the resultant paste under

water for a day or two, though this is not necessary. To the lime paste thus prepared enough sand and water are added to make a mortar of the desired working properties.

A word about the sand may be advisable. Lime paste contracts when it sets. This shrinkage is so great that the specimen usually disintegrates; in any event, it cracks badly and has no strength. Sand, acting as an inert filler, tends to prevent this contraction, and the presence of a certain amount of sand is absolutely essential if the mortar is to have any strength. The proportion of sand required for maximum strength varies with the quality of lime, but is generally from one to three times the weight of the quicklime used. More sand of course gives a weaker mortar but this decrease of strength is slight; so that, for instance, a 1 to 6 mortar is nearly as strong as a 1 to 3. The maximum amount of sand which can be used is governed not by the strength but by the working qualities. It will be found quite difficult to use a mortar as lean as 1 to 6. The sand should be clean and evenly graded as to size, with no extremely fine material.

It must be remembered that the final hardening of a lime mortar depends on the action of the air. For this reason it will not set under water, and its use is, therefore, not recommended for foundation work where the earth is back-filled against the masonry.

LIME IN PORTLAND CEMENT MORTAR

Lime is being used to some extent as an addition to Portland cement in both concrete and mortar. For this purpose hydrated lime only is of value. The use of quicklime is fraught with so many difficulties as to be almost prohibitive. It is claimed that the addition of about 10 per cent of hydrated lime to the Portland cement used in making concrete improves the material

in many respects. The Bureau of Standards is now conducting extensive research work to ascertain the truth of these claims. Mortars made from mixtures of Portland cement and hydrated lime in different proportions show a regular gradation in strength—the more lime, the less strength. However, the working qualities of the mortar are vastly improved by the presence of lime. This has such an important effect that masonry laid with mortar containing lime is frequently stronger than when cement alone is used, even though the former mortar is weaker. When a small amount of cement is mixed with lime mortar, the cement increases the rate of set but does not have any appreciable influence on the strength.

The use of lime for plastering and as whitewash is described elsewhere. Other building materials, such as roofing materials, metals, plumbing fixtures, wiring materials, and so on are covered under their respective chapter headings.

CHAPTER IV.

THE EXCAVATION AND THE FOUNDATION

THE first step in building a house is the foundation, the purpose of which is to support the house. This statement may seem superfluous, perhaps ridiculous. Yet there are many houses in which defects are traceable to foundations that have failed to perform their full duty. It still holds true that a house is no stronger than its foundation.

The majority of houses are constructed on foundation walls which form basements under the house. In this event it becomes necessary to excavate or remove sufficient earth to make room for the basement, or, failing in this, it becomes necessary to build up the foundation walls so as to make room for the basement. When the site is such that there is a decided slope to the terrain, it becomes possible to excavate at the upper end of the site and to build up the foundation walls at the lower end; and since excavating is generally more expensive than building up the foundation walls, considerable economy may be effected in this manner when the ground permits of such treatment.

In certain sections of the country full basements are not used. In this event the house is placed on piers of poured concrete, concrete blocks, brick, and sometimes, if the house is small, it rests upon wooden

posts. The average house, however, rests on a substantial wall. This wall, from the grade line to the cellar floor, is usually constructed of concrete, either poured to give what is called a solid monolithic wall, or laid up in concrete blocks.

THE BUSINESS OF EXCAVATING

Having decided on the site and the plan of the house, the ground must be broken and sufficient earth and rock if any must be excavated to provide room for the foundation, if the house is to have a basement or cellar. Because of the considerable cost of excavating, there is often a tendency to slight this feature of house building. It seems so unnecessary to spend good money for something which does not show in the finished house except as a cellar or basement, that many builders are apt to economize on excavation. This is done by reducing the size of the basement, so as to have a basement under only a part of the house while the remainder rests on piers or posts or plain foundation walls, or even by doing away with the basement altogether. But before the basement is dispensed with in whole or in part, the builder should give the matter due reflection and talk it over with local authorities. In some localities it is said that cellars or basements are not necessary, because the nature of the soil is such that no dampness and cold are transmitted up through the floors as the result of the nearness of the ground. The mere fact that houses continue to be constructed with expensive excavated basements or cellars should be proof sufficient that there is a good reason.

Also, there is a tendency to construct houses with high foundations so as to reduce the amount of excavation. Obviously, the higher the foundation walls the less earth must be removed to provide basement or

cellar room. Here the question is merely one of architectural treatment. Generally, it is rather difficult to make the average architectural treatment look well with a tall foundation wall, although there are special designs which are particularly intended for such an arrangement. Where the site is a rocky one which makes excavation a difficult matter, a tall foundation is quite justified.

Excavation is hard work, nothing else. It shows less for the labor and money expended than any other feature of building. After the boundaries of the excavation have been delineated by means of posts and taut strings, it is just a question of digging away and taking away the dirt. If the lay of the ground is such that the dirt may be used to advantage for filling in or levelling out, it should be put to one side and kept there for further use. Otherwise, it must be carted away. Occasionally, the dirt is of such a sandy nature that it can be used to advantage for the concrete used for the foundation walls, but this is a matter which had best be left to the experienced builder. Unless the dirt is absolutely satisfactory for this purpose, it should not be used.

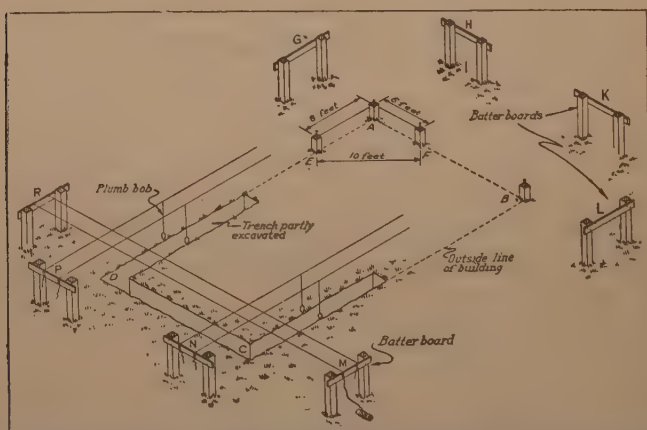
If the excavation requires blasting because of its rocky nature, then the expense will be considerable, although it may be offset in large part by using the rock for a stone foundation. Again, it is a matter of opinion whether to use such rock. If it is of good quality, then by all means should it be employed.

Speaking of stone it is interesting to note the possibilities of old land holdings which are surrounded by loose stone walls. In certain sections of the country where the land is filled with loose stones, it has been the practice to clear the land and use the stone to construct loose stone walls. Enterprising builders have not been slow to buy such land and tear down the stone walls in order to use the loose stones for founda-

tion walls. In some instances there is even sufficient stone for the entire walls of the house,

Excavation in dirt is generally done by day labor. It is a matter of shovel and brawn, although some enterprising contractors make use of horse-drawn or even tractor-drawn scoops which speed up the work materially. And once the excavation has reached the required depth, we are ready for the foundation trench and the foundation footings and walls.

To mark out a foundation area a stake is set at the location of one corner of the building. From this stake



How to mark out a foundation area by means of stakes, batter boards, string and plumb bobs.—Courtesy Lehigh Portland Cement Co.)

a string is stretched to another stake set in position corresponding to the other corner of the same side of the building. From this second stake a string is stretched to a third stake that is set at a point corresponding to the length of this side of the building. Before setting the third stake, however, it is necessary to square up the

corner at the location of the second stake, if the building is on a right angle. This is done by measuring off a distance of eight feet from the center of the second stake driven back toward the first stake, and setting a pin in the string at this eight-foot point. Then a distance of six feet is measured from the center of the second stake along the string leading to the third stake, and this six-foot point marked in the same manner. The person holding the third stake then moves it back and forth or to right or left as may be necessary, keeping the string tight meanwhile until the diagonal distance between the two pins is exactly ten feet, as determined by an assistant measuring with a ten-foot measure. The third stake should be driven firmly in place when this ten-foot distance has been accurately fixed. The corner marked by the third stake can be squared in the same manner, and so on until all four corners of the building have been located.

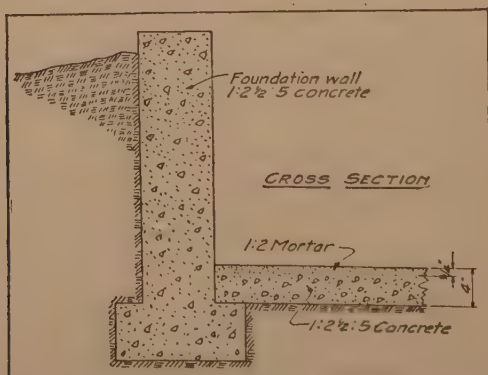
FOUNDATION WALLS MUST NOT BE CHEAPENED

Concrete blocks, poured concrete, brick and stone are the materials used for foundations; all are satisfactory when properly used. Poured concrete receives more attention here because it is in more general use.

Concrete, however, is not a synonym for permanency; there is good concrete and there is bad concrete. The strength of concrete for foundations is dependent upon the use of well-graded sand and gravel, mixed in proper proportions with cement and water. It is important that concrete should be prepared and applied under experienced supervision.

Concrete is a mixture of cement and sand with a course aggregate which may be either broken stone or pebbles, and the strength of the concrete varies in proportion to the amount and kind of each of the materials used. The harder the aggregate, the stronger the concrete.

For ordinary foundation work, a mixture composed of one part of cement to three parts of sand and five parts of broken stone or pebbles will be amply strong. Good work can be obtained by the use of more sand and



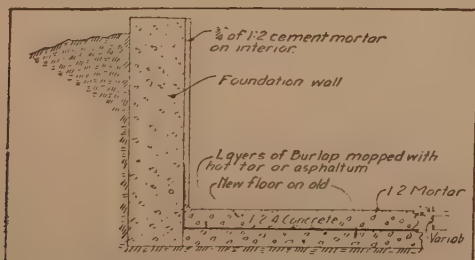
Concrete basement foundation wall, showing the proper kind of footing as compared with the wall, and the thickness of the cellar floor.—
(Courtesy Lehigh Portland Cement Co.)

aggregate, but in any case the mixing should be thorough and the materials should be of the best, especially if concrete is required as a support.

To mix concrete properly, each of its ingredients should be measured, and in no case should the contractor be allowed to measure by shovelfuls, for the man who shovels the sand and gravel is apt to be stronger than the one who measures the cement. Mixing should be done on a tight platform placed on the ground, or in a concrete mixing machine. Cement and sand should first be mixed dry and the combination should be spread over the aggregate and water sprinkled over this while it is being turned over. It should be turned over twice at least.

There has been a tendency to cheapen foundation walls by making them thinner than they should be. The thickness of foundation walls is a matter usually governed by local building codes. These codes, and likewise good practice, require walls at least twelve inches thick, and in the case of stone or brick walls, sixteen inches thick. Cement mortar with a small portion of the cement replaced with dry hydrated lime, should be used for stone and brick foundations; lime mortar neither gives as great strength nor makes the foundation as water-proof.

Foundation walls are enlarged at their base in order to furnish a larger bearing surface against the soil beneath. This enlarged base is termed "footing." One can readily see that the footings are an important part of the foundation and particular attention should be paid to their size and shape. In the house where cheapness is the paramount issue, the footings



Alterations suggested for wet cellars, where outside of wall cannot be reached nor drainage of foundation provided. The thickness of new floor depends on height of ground water above basement floor during wet weather.—(Courtesy Lehigh Portland Cement Co.)

are frequently slighted. It is apparent to the reader that these footings, which must bear most of the weight of the structure, should be carried down to

firm ground and below the frost line. The folly of placing them on frozen ground is likewise readily seen.

No end of house ills and annoyances result from improper footings. Poor footings cause uneven settling of the foundation walls and this in turn is transmitted to the whole house, throwing it out of plumb. The damage is visible inside the house in the form of cracked basement walls, cracked plaster on the upper floor walls, binding doors and windows and sloping floors. Joints in the woodwork will be forced open both inside and outside the house. Nor are these all the evils that can be ascribed to faulty footings and uneven settling of the walls. The pitch of the gutters may be altered, causing water to back up instead of flowing off. This water will overflow the gutters and may back up under the roofing, ruining the housewife's disposition by marring and staining interior decorations. Considerable expense may be involved in redecorating. This annoyance will continue with every thaw or heavy rain until the gutters are repaired or rebuilt.

Often footings that are correct in every way are undermined to permit the entrance of service connections and rain leaders. This weakens the footings at this spot and may result in some of the house ills just mentioned. At the places where it is necessary to undermine footings they should be either enlarged or, better still, reinforced with steel rods.

THE MECHANICS OF THE CONCRETE FOUNDATION

Where soil conditions lack the best supporting capacity, the foundation wall proper is usually built on a footing, which is a wider section of concrete, varying in thickness to meet the conditions, laid in the bottom of the foundation trench and on which the wali proper

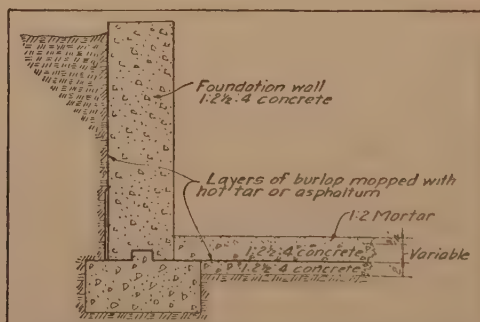
is started. After good bearing area is secured through spreading out a footing, say ten or twelve inches wide, and six to eight inches thick, the foundation wall proper may be only six inches thick if a small building is to be carried.

Dimensions of footings must be varied in accordance with the bearing capacity of the soil. It is quite impossible to give uniform width for footings, but it is an easy matter to make tests of the soil and from these determine the dimensions required. The average barn has walls from eight to ten inches thick, and may require a footing two feet wide and twelve inches thick to support the load for the structure. For a two-story house having eight-inch walls, soil conditions may require a footing 18 inches wide and 12 inches thick. If it is not convenient to determine the actual bearing capacity of the soil, common practice requires footing just to be on the safe side. The accompanying table shows the bearing power of soils in tons per square foot:

	Supporting Power in Tons Per Square Foot
Rock—in thick layers, in natural bed...	200
Clay—in thick beds, always dry.....	4
Clay—in thick beds, moderately dry....	2
Clay—soft	1
Gravel and, coarse sand, well cemented..	8
Sand—compact and well cemented.....	4
Sand—clean and dry.....	2
Loam soils	0.5

The thickness of foundation walls, like thickness of foundations, depends upon the load to be carried. Ordinary building walls necessary for such structures as poultry houses, garages, houses, and barns, range

in thickness from six inches for small buildings to ten or twelve inches for larger ones. Foundation walls for ordinary buildings without a basement or a cellar



Construction of foundation and basement floor to provide against maximum water pressure when building in damp soil. Note the water-proofing provisions.—(Courtesy Lehigh Portland Cement Co.)

need not be made of a very rich mixture. Absolute watertightness is not necessary. Therefore, a $1:2\frac{1}{2}:5$ or $1:3:6$ mixture or even leaner may be used. For watertight wall construction a $1:2:4$, $1:2\frac{1}{2}:4$, or, in extreme cases, where much ground water is to be encountered, a $1:2:3$ concrete, should be used for the foundation walls of buildings having basements or cellars.

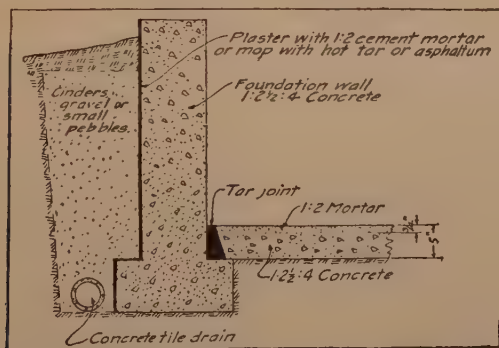
THE QUESTION OF REINFORCEMENT

It is common practice to play safe by reinforcing walls with a small amount of $\frac{3}{8}$ -inch round steel rods placed at the wall center and spaced about two or two and one-half feet, center to center, vertically and horizontally. If walls are between eight and ten inches

thick, two such sets of reinforcing are sometimes used, one set being placed two inches from the exterior face of the wall and the other the same distance from the interior face. Window and door openings have corners where cracking may occur, due principally to temperature changes. Such openings are usually framed with rods parallel to the sides and diagonal with each corner. In a case of concrete lintels such units are properly reinforced when precast, or as cast in place.

In excavating for foundations the trench should be carried deep enough so that its bottom will extend below possible frost penetration to firm bearing soil. Otherwise, upheaval due to expansion of the soil when freezing may cause cracking of the foundation which will probably extend up into the structural wall.

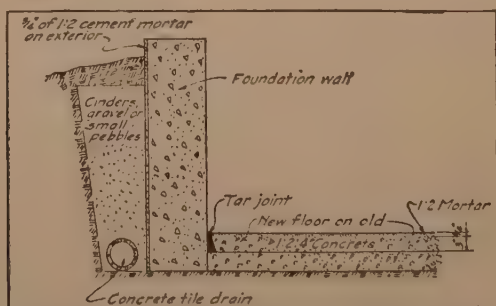
In some cases only single form sections may be required in some foundation work, where the natural



Another type of construction for foundation and basement floor in damp soil. Note the treatment of the ground outside the foundation wall.—
(Courtesy Lehigh Portland Cement Co.)

soil is firm enough to be self-supporting. This, of course, applies only to the concrete work below and

up to the ground level. From that point upward forms must be provided on both sides of the concrete. In soils that are not naturally well drained it is sometimes necessary to lay a tile drain at the bottom of the foundation trench and just outside the foundation wall or footing, leading to some natural outlet or drainage bed; otherwise, a house cellar, for example, might be damp at certain seasons of the year, owing to the water leaking into the cellar through a neglected construction joint in the wall, or because the joint between foundation wall and concrete floor was not



Repairing existing concrete to prevent seepage of ground water. In this case the outside of the wall can be reached. Special soil treatment, a coat of cement mortar on the outside, and a concrete tile drain are employed.—(Courtesy Lehigh Portland Cement Co.)

properly sealed. The accompanying illustrations deal specifically with these features of construction.

Monolithic concrete walls above ground are usually made of a 1:2:4 or a 1:2½:4 concrete. Field stones, ranging in size up to four, five, or perhaps six inches in diameter, may be used to advantage in ordinary concrete foundations. By ordinary foundations is meant those which are not intended to enclose a base-

ment or cellar, but merely to support the structure. The use of such stones in proper ratio to the concrete mixture itself results in considerable economy. Such stones are frequently referred to as rubble stones or nigger-heads. If used as indicated, the following precautions must be observed:

The stones must be cleaned and free from all adhering material, such as loam, clay, and moss. They should be wet immediately before being placed in the trench with the concrete, and no stone of this kind should be larger in greatest dimensions than one-third the thickness of the foundation wall or other section in which it is to be used. In placing such stones they should not be dumped into the trench promiscuously with the concrete, but rather distributed uniformly by hand so that they will lay at least two inches back from the face of the wall and no nearer to each other in the wall than will permit surrounding them completely with the concrete mixture.

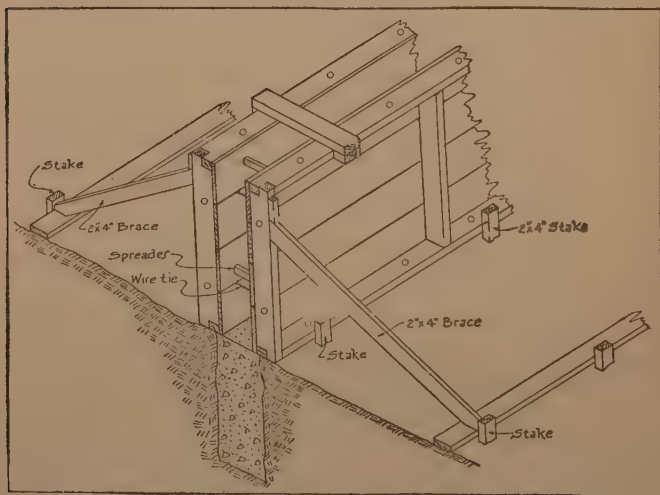
THE USE OF CONCRETE BLOCK

Concrete block is being used more extensively in all kinds of foundation work, particularly for small and medium sized structures. Usually an ordinary concrete footing is laid first and the block masonry wall started upon this. When using concrete block, the principal precaution to take is to be sure that they are well and uniformly imbedded in a rich cement mortar, not leaner than $1:2\frac{1}{2}$ or $1:3$, and that all joints are well filled and pointed up. If this is not done, spots will occur where leakage will give trouble. As an added precaution, block foundation walls are usually given a quarter-inch coat of rich sand-cement mortar on the exterior before the foundation trench is back filled. The proper mortar proportions for coating and pointing is a $1:1\frac{1}{2}$ mixture.

Block walls for ordinary square or rectangular buildings need no reinforcement. Precast window-sills and lintels are usually reinforced.

WHAT MAKES CELLARS DAMP

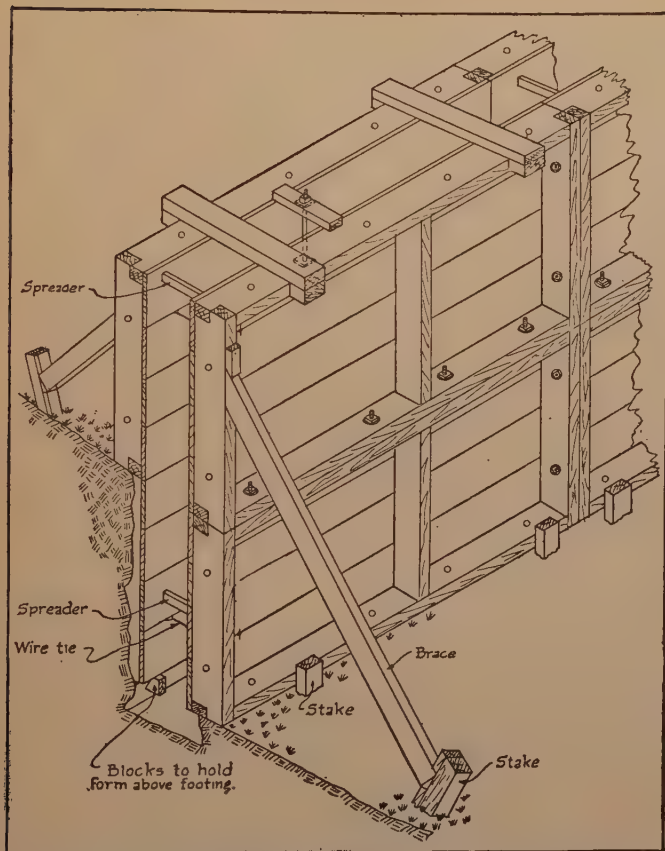
There is nothing worse than a damp or wet basement. In addition to being unserviceable, such a cellar is



Forms for a foundation wall that does not call for a basement. Panels can be added either to the length or to the height. The footing has already been cast.—(Courtesy Lehigh Portland Cement Co.)

unhealthful. Happily, however, this disagreeable and common fault can be avoided to a certainty. Being the point of contact between the earth and the house, the foundation should be built to withstand moisture, which increases in intensity during prolonged wet spells and February thaws. The wall, then, must be water-proof beyond the most remote contingency.

Any wall which is built in low or marshy ground



For simple foundation work it is often unnecessary to use forms for placing concrete in the excavated trench. Above ground, forms must be used. Here is a suggested method of adapting standard form panels, which may be made as high or as long as desired.—(Courtesy Lehigh Portland Cement Co.)

should have an earthenware drain laid around its base, so that water seeping through the soil will not enter the cellar. Troubles from water in the cellar are particularly apt to be found in dense soils, clay and hardpan, because all earth contains a certain amount of water, which is seeking an outlet, and a poorly built cellar wall makes it easier for the water to pass through its interstices than to penetrate the surrounding soil. Even a wall built of good materials is liable to leak, because of the carelessness of the mechanic who has not filled in some portion of it thoroughly solid.

Nevertheless, there is one particular type of foundation construction on which full reliance may be placed, and that is vitrified brick laid up in Portland cement. After the wall is finished, the outside should be given a coat of hot tar on all portions that are below grade. This treatment necessitates a slightly larger excavation in order to allow room in which to apply the tar. The expense is thus increased somewhat over the usual method of running the wall flush against the earth, but it must be considered that the foundation is the base upon which the house is to stand permanently, and it is well worth the necessary cost to insure against disintegrating effects of moisture.

The basement or cellar floor should be of a rich Portland cement mixture, and not less than four inches thick. A layer of ashes at least three inches thick is placed over the levelled ground, to serve as a foundation for the cement. Too much sand in the cement mixture results in a soft floor, which will offset all the advantages of a weatherproof wall. However, since a chapter further on is largely devoted to cement and concrete work, little need be added here.

BEARING POSTS AND PORCH PIERS

The foundation supports the outside walls and the

weight of about half of the floor area. The remainder of the weight of the house is dependent upon the bearing posts for support. The bearing post footings should, therefore, not be neglected. Care should be exercised to see that trenches for water and sewer pipes are not dug close to these footings, as this will have a weakening effect on them.

When bearing posts settle unduly the effect is apparent throughout the house. Plaster cracks appear on inside walls, doors and windows become balky and floors settle at the inner walls. The annoyances that result from uneven floors are familiar to everybody.

Workmen who would not slight the footings under the foundation walls or those under the bearing posts, sometimes fail to realize the importance of the porch piers and their footings. The porch piers are put in for the very practical purpose of supporting a porch; a sagging porch will surely result if the piers are not properly "rooted." Probably no one thing gives a house such a run-down, hang-dog look as a sway back porch. And appearance, it must be remembered, has a direct effect on the resale value of the house. What is more, the sagging porch, with consequent gutter trouble, will treat the owner and his guests to many a mild shower bath as they enter or leave the house.

The importance of proper foundations, bearing posts, porch piers, and their footings, cannot be too strongly emphasized, for any settling must of necessity affect the entire superstructure of the house.

WHEN THE FOUNDATIONS SAG

Please be sure to remember that the time to make the foundations right is when the house is being constructed. Little can be done in the way of correcting foundation troubles, once the house is built. The author experienced considerable trouble with settling

foundations in the case of a house which he bought. The house was some fourteen years old and, upon superficial examination, appeared to be well built and quite typical of the honest pre-war construction.

However, living in the house but a few months brought out many building faults which could not be detected by a superficial inspection. First of all, the foundation walls had insufficient footings, with the consequence that they were steadily sinking—not very much, to be sure, but sufficient to cause serious cracks in the cellar walls and cracked plaster and distorted door frames throughout the house. To make matters worse, the house had a center chimney to which the builder had given insufficient care. Instead of providing a big, broad, deep footing, he obviously slighted the foundation for the chimney. And then, to heap trouble upon trouble, the builder ran his main girders to the chimney, causing it to support the extra load. As the chimney sank from improper footing and too much additional weight, it pulled down the floors some two inches. The floors had to be jacked up and posts were provided to take the weight off the chimney. The baseboard had to be replaced, doors had to be planed to fit the warped door frames, and other alterations were required.

The moral of which is that it pays to build a good foundation in the first place.

CHAPTER V.

THE FRAME HOUSE AND THE CARPENTRY OF ALL TYPES OF HOUSES

WHETHER a house is of the frame type or some other type making use of stone, brick, hollow tile or concrete for its externals, the prime factor is the carpentry. Irrespective of the walls, there is a vast amount of work which entails the use of lumber and the skill of the carpenter. Hence this chapter, which, while primarily devoted to the frame house, also deals with the carpentry of the house irrespective of type.

For the greater part of the material and the illustrations presented in this chapter the author is indebted to the Weyerhaeuser Forest Products of St. Paul, Minn., and their excellent copyrighted publication entitled "The High Cost of Cheap Construction," drawings and data from which are reproduced by permission.

TYPES OF FRAMING

The framework of the house has aptly been termed its skeleton, and its purpose obviously is to give strength and rigidity to the structure. The subject of house framing is a technical one and would have no place in a book of this kind were it not that so much of house satisfaction is dependent on this part of the building. It is not necessary that the prospective builder know all of the details of the various types of

framing or, for that matter, the method of constructing the one type he chooses, but the builder will find an acquaintance with house framing invaluable in his effort to secure a good house.

There are many types of house framing in use in various sections of the country, but for practical purposes they may be grouped into four classes—the braced timber frame, modern braced frame, balloon frame and platform frame.

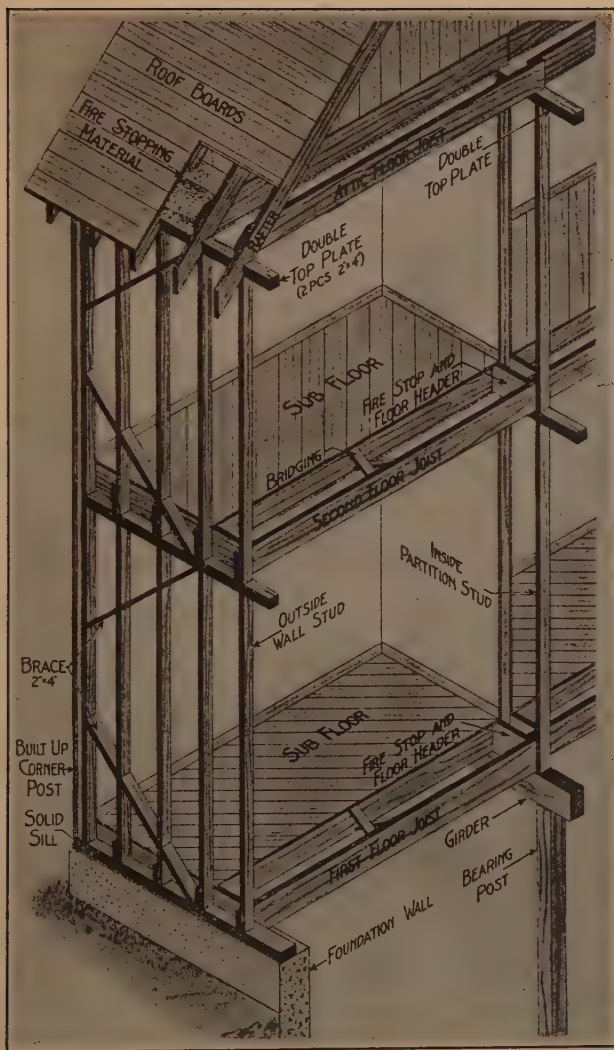
THE BRACED TIMBER FRAME

The braced timber frame is the oldest type and originated in New England. The early colonists brought with them a tradition of heavy, European half-timber construction and this was nourished by the abundance of standing timber directly at hand. Nails had to be made by hand; therefore, the early craftsmen used them sparingly, devising methods of fastening that consisted of mortises and tenons held together by wooden dowel pins.

The principal framing members of the old New England houses were often hewn out of the trees nearest at hand and were ordinarily of much larger dimensions than were required to give the necessary strength. The time required in those days to prepare the timbers necessary for the building of a house, as well as the time required for its building, permitted the timbers and framing members to dry out thoroughly before the building was completed. And under these conditions the old braced timber frame resulted in a practically faultless house of which hundreds of old houses still standing in the eastern states today bear evidence.

THE MODERN BRACED FRAME

In those sections of the country where many of the old braced timber frame houses still stand, a modern



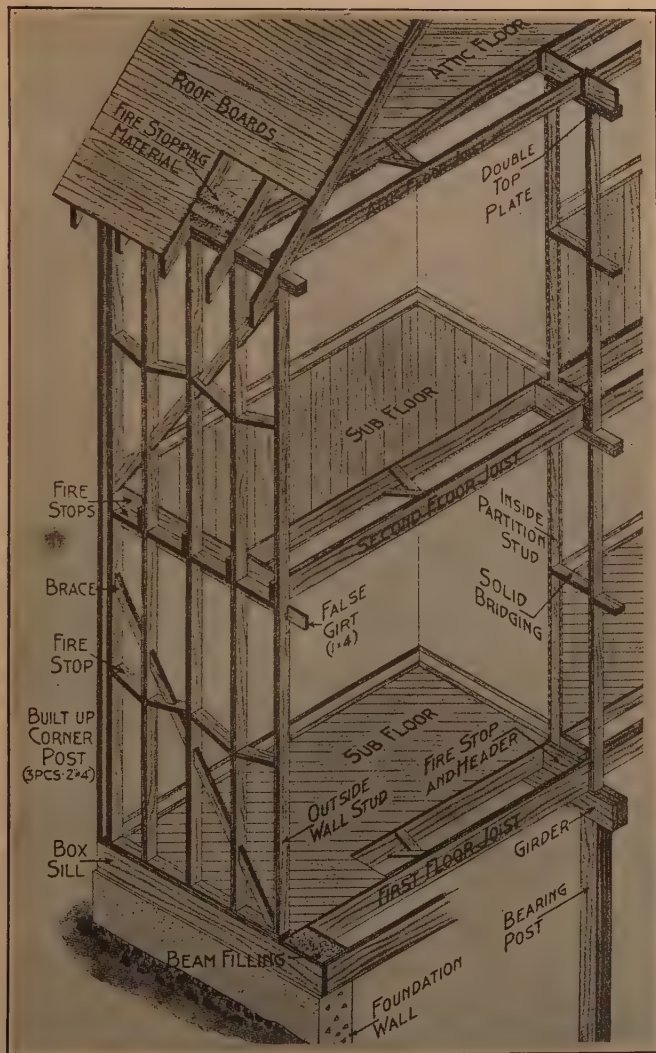
The modern braced frame, as it should be built. This makes an entirely satisfactory and efficient frame.—(Courtesy Weyerhaeuser Forest Products.)

adaptation of the old braced timber frame has been developed. This type of frame is sometimes called the "combination frame." Corner posts and girts built up of two or three pieces of two-inch lumber take the place of the solid timbers formerly used. Nails largely replace mortises, tenons and dowel pins for fastening. With the elimination of the heavy timber girts the intermediate posts formerly required to support them have been done away with and the studs, in addition to furnishing bearing surfaces for the inside and outside walls, are utilized for support as well. The corner bracing, however, is retained, as is, in most cases, the solid sill.

This modern braced frame is in every way adaptable to modern building needs, yet to be thoroughly efficient should not be slighted in its construction. This method of framing is shown in the accompanying drawing, complete as it should be built.

THE BALLOON FRAME

The balloon frame is another modern and accepted type of framing applicable to the building of substantial houses in all parts of the country. As is the case in the modern braced frame it is built almost entirely of two-inch lumber. Nails are also used for fastening in place of mortises and tenons. The distinguishing feature of the so-called balloon frame, however, is that the wall studs are made to extend up two stories high with the ends of the second floor joists spiked to their sides and resting upon a false girt or "ribbon board" which is notched into them on the inside. A box sill is ordinarily used with this type of framing. The elimination of the girts in the walls has required the fitting of fire-stops between the studs to prevent the circulation of air throughout the walls. Floor headers and fire-stops between the joists accomplish a similar pur-



The balloon frame, as it should be built. This frame has qualities and advantages that cannot be found in other types.—(Courtesy Weyerhaeuser Forest Products.)

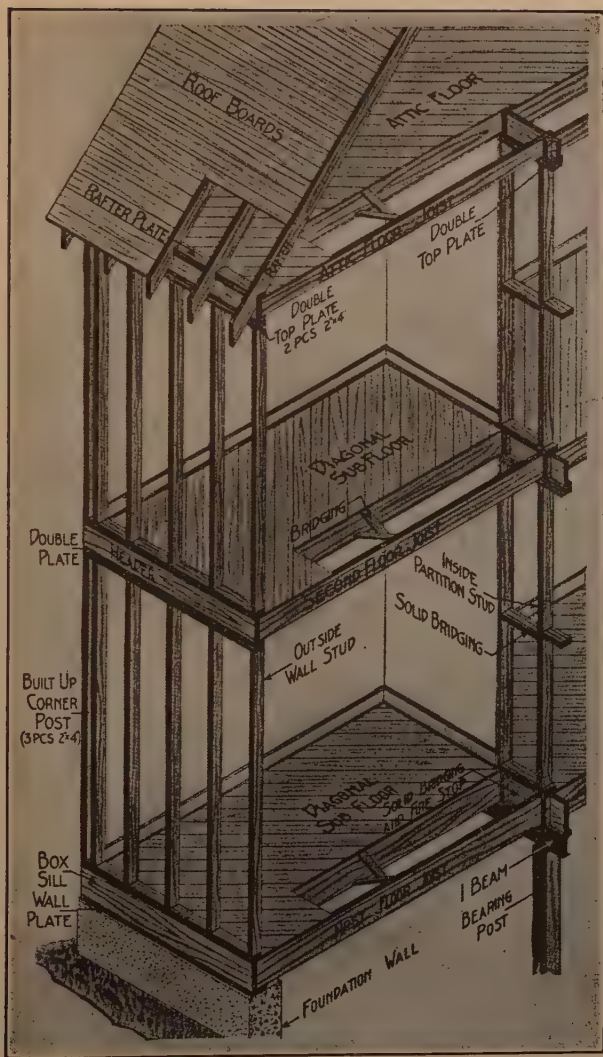
pose. The sub-floors are laid diagonally with the joists. The bearing partition studs rest upon the girders. Corner bracing is also required.

The advantages of the balloon frame are largely those of speed and economy in erection as well as a little more rigidity. Properly constructed, it is in every way to be recommended and is rapidly coming into greater and greater favor among discriminating builders everywhere, although it is a type which first developed in the west.

It is unfortunate that so logical a type of framing should be so grossly abused by careless builders in their over-zealous quest for speed and cheapness. It seems to have developed in two diametrically opposite directions. In the one case it has been improved to the point where it meets successfully all the demands of efficient building practice. In the other case it has been cheapened through harmful "corner-cutting" into a flimsy, short-lived structure. While appreciating the good points in the properly constructed balloon frame, it is well, at the same time, to guard against the construction abuses to which it is often subjected.

THE PLATFORM FRAME

The disregard by many builders of one very important consideration in the construction of a house frame has led in recent years to the development of a newer type of frame called the platform frame. During the life of a house the lumber of which it is constructed undergoes many variations of temperature and humidity. Even thoroughly air-dried lumber will be further dried out under the artificial heat in a house in winter, and, as its moisture content is reduced, it is bound to shrink somewhat. This shrinkage in lumber, however, occurs across the grain rather than with the grain; that is, the shrinkage in the lumber lengthwise is neg-



The platform frame, in which the first floor is built on the foundation as though it were a platform. The second floor forms another platform, and so on.—(Courtesy Weyerhaeuser Forest Products.)

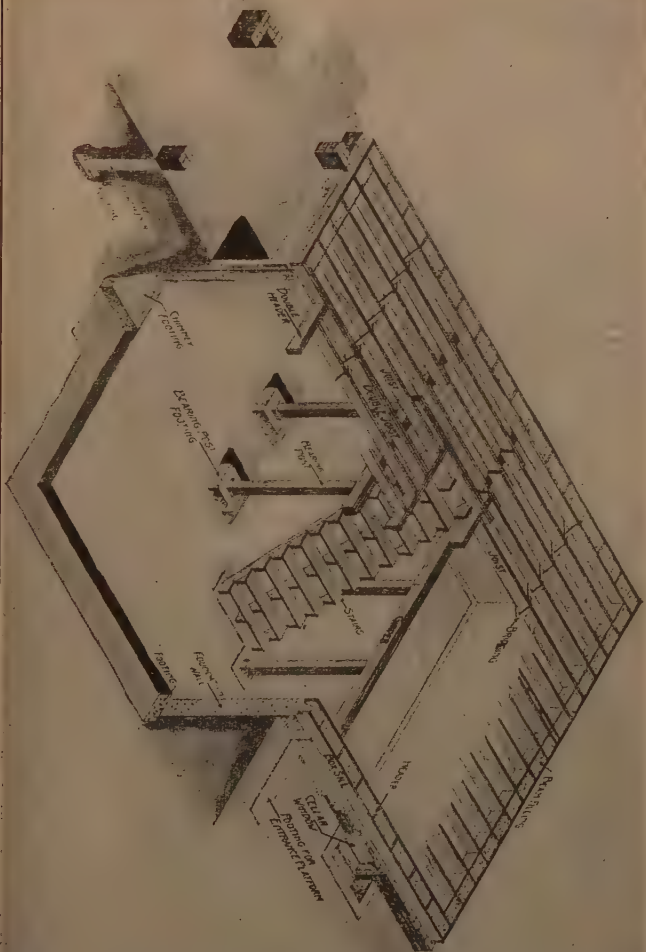
ligible, while the shrinkage across the grain is often quite marked, depending upon its moisture content at the time it is set in place. Therefore, please note that in the properly designed balloon frame and modern braced frame, already illustrated, the amount of horizontal framing lumber subject to shrinkage has been reduced to a minimum in the walls and bearing partitions, in an effort to eliminate, as far as possible, the settling that is bound to occur as the lumber dries out.

In the platform frame the amount of horizontal framing lumber in the outside walls and inside bearing partitions has been equalized. The main fault in this frame, however, is that it accomplishes its end not through a reduction in the amount of cross sectional lumber subject to shrinkage but by the addition of more. It also lacks some of the stiffness found in the other two types just discussed and is not recommended for houses that are to be covered on the outside with stucco.

It is poor economy in house building to so limit the builder in both time and materials as to make it necessary for him to slight the construction of the house frame, for without a substantial frame you cannot have a satisfactory house. Upon the frame of a house depends not only its strength, but much of its all-round qualities as well.

SUPPORTING TIMBERS

Most home-builders have never heard of a house collapsing or of floors suddenly giving way, and, therefore, there is a rather general impression that all houses are strong enough. Nor is the home-builder wrong in the feeling of security which he harbors, for few indeed are the houses whose supporting timbers are not sufficient to carry even heavier loads than they will ever be called upon to bear.



First stage in the construction of a house. The foundations and piers have been completed and the carpenter work begun. This particular construction is for the balloon frame—(Courtesy Weyerhaeuser Forest Products.)

"Why, then," the prospective builder is quick to ask, "must I interest myself in the supporting timbers in my new home?"

The answer is simple. Many house annoyances are caused by cheapening the house through the use of undersized supporting members.

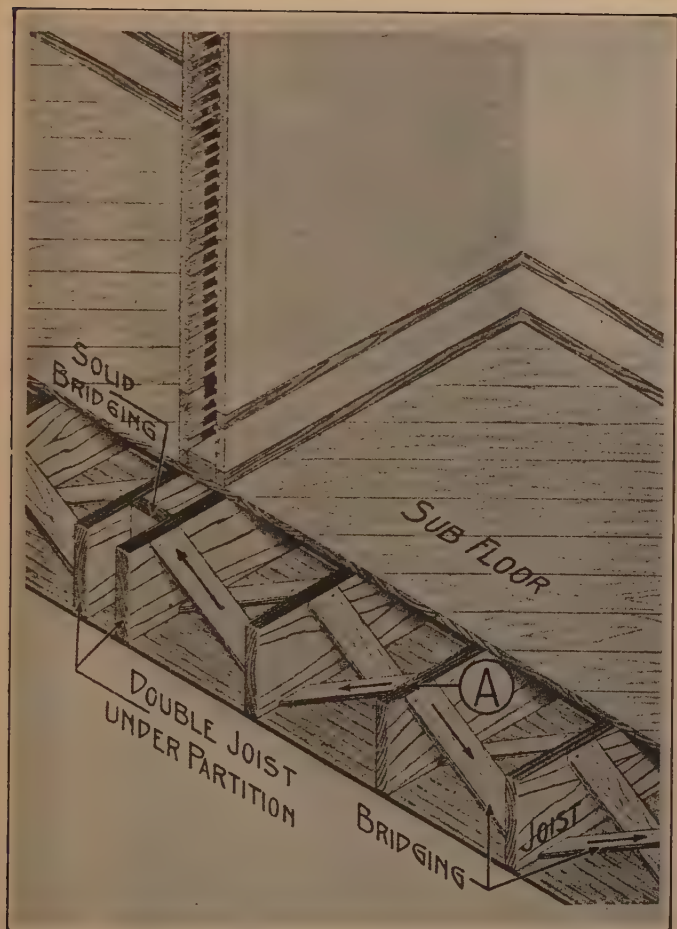
How to determine the size and spacing of supporting timbers, involving as it does engineering problems, will not be treated at length in this book, especially since every house presents problems which must be treated on their own individual merits. For the owner whose home is designed by a capable architect and built by a conscientious contractor, it is safe to assume that this matter will be taken care of satisfactorily.

The function of the supporting timbers is not merely to prevent the house from tumbling down. Many a house is cheapened by the use of undersized or too few supporting timbers and yet has strength enough to support any ordinary load. But these houses lack stiffness. And stiffness is vital to the satisfactory house. Its absence leads to the hundred-and-one house ills that result in constant annoyance, innumerable repair bills and shortened life.

POSTS AND GIRDERS

The outer ends of the joists which support the first floor rest directly upon the foundation wall, or on a sill which, in turn, rests upon the foundation wall. The inner ends of these joists rest upon girders which are supported by bearing posts as illustrated in the accompanying drawing.

These girders and bearing posts support the main bearing partitions as well as a part of the weight of the floors and the contents of the house. They should therefore be of a size sufficient to support this weight. What has been said above about determining the size



Proper bridging of floor joists so essential to good house construction. A load applied to a properly bridged floor joist is transmitted through the bridging to the neighboring joists and thus absorbed without damage to the ceiling below.—(Courtesy Weyerhaeuser Forest Products.)

and spacing of supporting timbers applies, of course, to the posts and girders.

SILLS

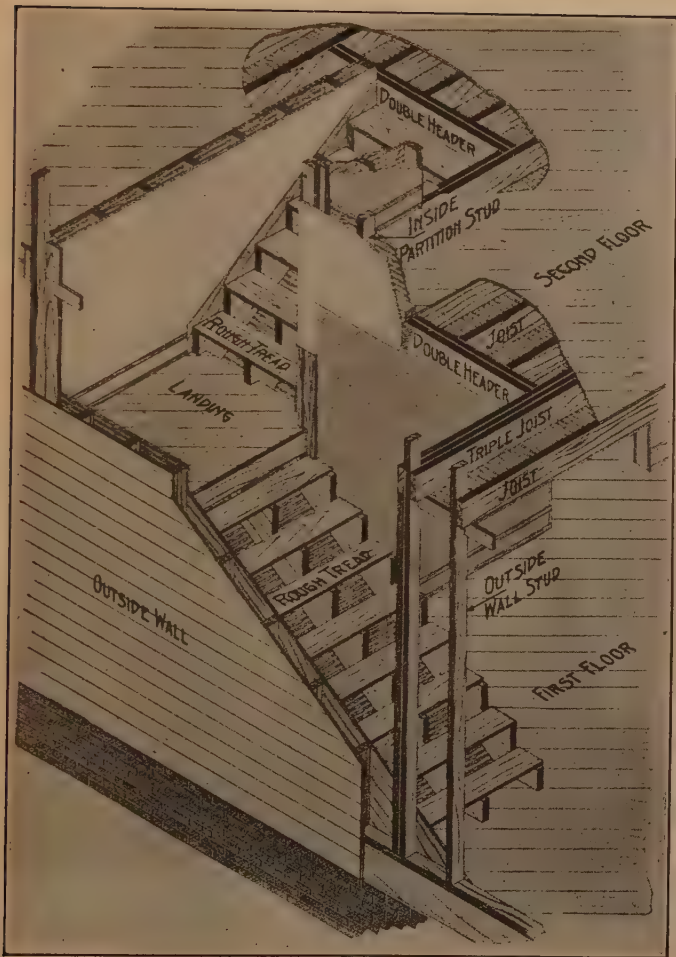
The sill furnishes a means of securing the superstructure to the foundation and provides a nailing surface for the joists. There are several types of sills in use which have the approval of good builders; three of these are shown in the drawings of the different types of frame construction.

If a house is to be firmly anchored to the foundation (and it surely should be for a number of reasons) the sill must be more than merely set on the foundation. The solid or timber sill should be anchored by means of bolts, and the box sill by concrete, known in this use as "beam-filling." This beam-filling also seals the joint between the framework and the foundation. When a solid sill or a combination sill is used the joint between it and the foundation should be sealed by placing the sill, or the plate, on a bed of mortar.

In the hurry-up kind of construction this anchoring and sealing is often neglected or done in such a haphazard manner as to be worthless. Good workmanship in such places as this costs no more, and you will find it worth while to see that you get it. With good foundations and footings, and with the primary supporting members of the house properly taken care of, you have a good start on a substantial house.

JOISTS

The joists furnish the support for the floors. Joist sizes, like girder sizes, are dependent upon the length of the span they bridge and upon the load they are required to carry. Failure to use joists of sufficient size is sometimes the cause of sagging, squeaking floors that seem insecure under foot, rattling light



Stairway detail, showing how it becomes necessary to cut away one or more of the floor joists for a stairway, and how the strength lost is regained.—(Courtesy Weyerhaeuser Forest Products.)

fixtures and cracked plaster in the ceilings underneath.

Floor joists are often seriously weakened by mechanics when they are installing the plumbing and heating systems. It is highly important that the carpenters, who are familiar with the requirements of these framing members, do whatever cutting and notching of framing members as may be necessary in this connection. It also becomes necessary to cut away joists for stairways, chimneys and other floor openings. This obviously weakens the floor structure and this lost strength must be regained. Just how it is done is illustrated in the accompanying drawing.

BRIDGING FLOOR JOISTS

By bridging is meant those small braces that extend crosswise from the top of one joist to the bottom of the next and in a straight, continuous line the length of the house. A trip to your basement will, or should, reveal one or more rows of bridging. It may be difficult to realize the value of these small braces, but their importance can hardly be over-emphasized.

The purpose of bridging is to keep the joists in alignment and to distribute to all of the joists any exceptionally heavy, concentrated loads or sudden jolts that may be applied directly above one or two of them. Tests have shown that it requires three times as much weight to cause a certain amount of deflection in a bridged beam as it does to cause the same deflection in one that is not bridged. Our drawing illustrates one good method of doing this bracing. Bridging is just as necessary between the second floor joists, joists, though, of course, it is not visible in the completed house.

It is difficult to remedy defects due to poor bridging, or lack of bridging, once the house is built, but a simple matter to check during construction.

FLOORS

Throughout this book the reader will find references to creaking, buckling and altogether unsatisfactory floors. Some of the causes for this condition have been pointed out, such, for instance, as uneven settling due to faulty footings or insufficient size of joists and girders. Even though all of these points are properly taken care of, distressing floors can still result from the improper laying of the floors themselves.

SUB-FLOORS

The sub-floor is the rough under floor which is nailed to the joists and over which the finish floor is laid.

The sub-floor, if laid diagonally over the joists, gives a better foundation for the finish floor, and especially on the upper floors, also adds considerable stiffness to the structure. On the first story in some types of framing, and on the upper stories in most types, it is a trifle more difficult to lay the sub-flooring diagonally, as this requires headers in between the joists to provide a nailing surface for the ends of the floor boards. However, since these headers, when properly fitted and nailed, are very valuable as fire-stops, there should be no objection to the slight additional material and labor necessary to lay the sub-floors in this way.

The importance of properly nailing the floors can hardly be overstated. Many people are surprised to learn that it is the working up and down of the nails in their sockets that causes the annoying creaking and squeaking of floors when they are walked over. Bulging, humpy floors are also often the result of too few nails or of improper nailing. A nailing schedule for the laying of sub-floors is shown here.

For 4-inch boards—Use 2 nails per board per joist.

For 6-inch boards—Use 2 nails per board per joist.

For 8-inch boards—Use 3 nails per board per joist.

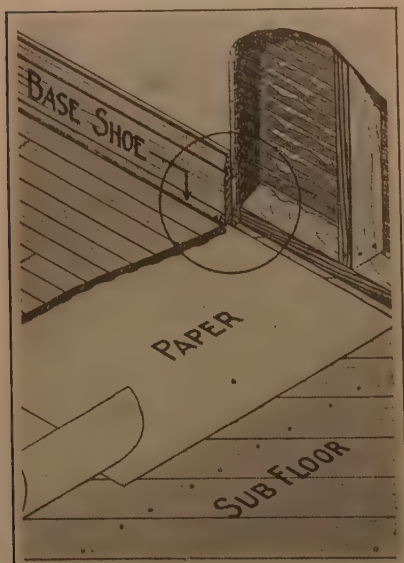
For 10-inch boards—Use 3 nails per board per joist.

For 12-inch boards—Use 3 nails per board per joist.

Since the finish floors are almost the last thing to go into a house, they will be discussed farther on in the book.

PORCH FLOORS

No flooring receives harder wear than that on the



Proper way to build floors, showing the sub-floor laid diagonally, the flooring paper, and the finish floor.—(Courtesy Weyerhaeuser Forest Products.)

porch. Exposed alike to rain and snow, wet one minute and subject to a hot sun the next, receiving little attention or care, the porch floor has much to contend with. Attention to the following points, however, will add materially to its life.

1. The porch floor should have a slight pitch so that water will run off quickly. Substantial piers and footings are necessary to assure an even floor year after year.

2. Porch flooring should be dry when

laid. If laid when wet, the consequent shrinkage will open the joists, not only marring the appearance of the

floor, but also forming innumerable dust and dirt collectors.

3. The joints of the porch flooring should be given a coat of white lead and oil just before the flooring is laid, and the whole floor, particularly under columns, should be painted immediately after being laid. A fresh coat of paint each year will greatly increase the life of the floor.

4. Circulation of air under the porch should be provided so as to protect the joists sills and floor against decay.

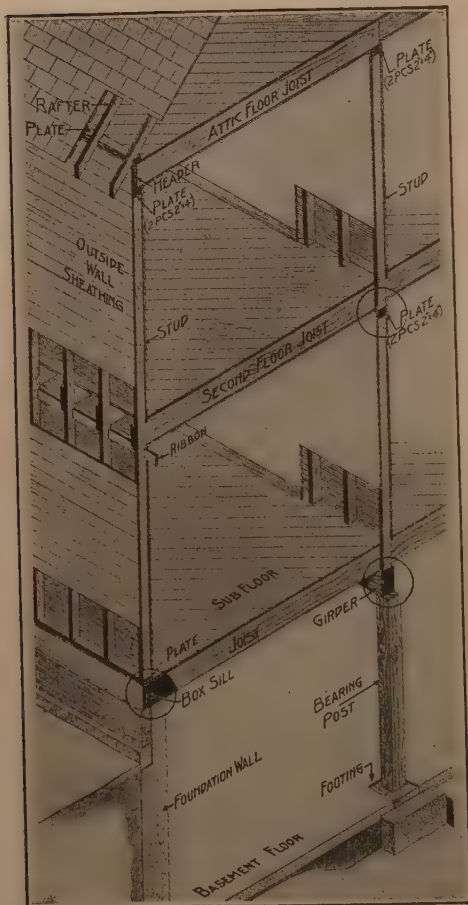
5. In painting porch floors it is well to select a special kind of paint for this specific purpose. No painted surface is subjected to the wear and tear that is commonplace with porch flooring, not only as the result of weathering, but more particularly the wearing action of shoes. Most paint manufacturers put up special hard-drying paints for porch floors, which should be applied in two coats for a substantial covering. The paint should be freely applied, so that it will sink into joints and fill them up flush with the floor surface. Such paint, too, should never be thinned, since its heavy consistency is what gives it the hardness and wearing qualities. It should be given plenty of time to dry hard.

BUILDING AGAINST SHRINKAGE

Shrinkage is the natural result of the drying of wood. While certain difficulties in many houses are traceable directly to it, it does not follow that these defects need be a part of the wood house. How, then, is it possible to build so as to eliminate the evils of wood shrinkage?

The answer involves, first, the use of air-dry lumber, and, second, a few simple construction methods very generally overlooked by the average house builder.

Water exists in wood in two conditions—as free



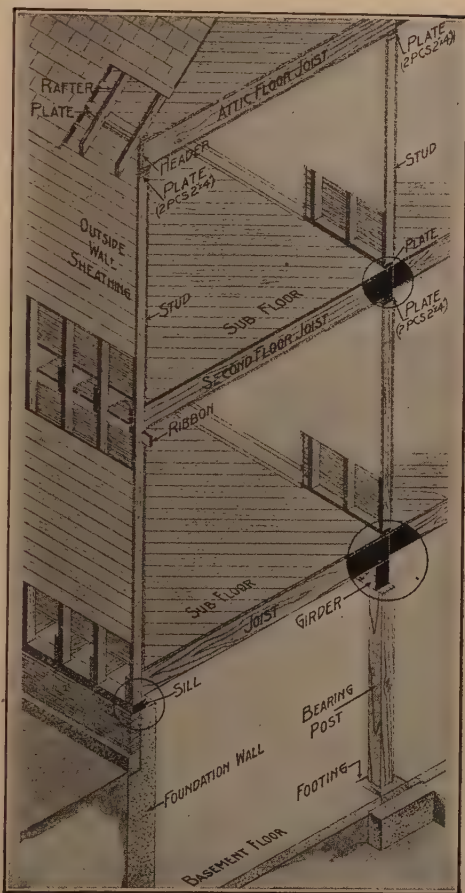
Method of building against shrinkage by equalizing and minimizing the amount of lumber the shrinkage of which would cause settlement.—(Courtesy Weyerhaeuser.)

water contained within the cell cavities; and as water absorbed in the cell walls. Removal of the free water merely reduces the weight of the wood; shrinkage begins with the removal of the absorbed water and the amount of shrinkage that will take place in a piece of wood is directly proportionate to the amount of moisture which the cell walls have absorbed.

Therefore, since green lumber with a moisture content of 25 to 30 per cent will shrink much more than air-dry lumber with a moisture content of only about 15 per cent, the wisdom of using only air-dry lumber in the framework of

a house is immediately apparent.

Shrinkage of wood, however, like the expansion and contraction of iron, cannot be entirely eliminated. Just as iron expands under heat and contracts when cooled, so lumber, unprotected by paint, takes on and gives off moisture according to the variations in the humidity of the surrounding atmosphere. As a house ages the lumber in its framework, subjected to the dry artificial heat in winter, may, over a period of years, dry to a moisture content as low as 8 or 10 per cent and may shrink accordingly. It is not practical to use framing lumber in the building of a



Common method of framing, showing how the shrinkage problem is unsolved. Solid black parts indicate relative amounts of lumber the shrinkage of which would cause settlement.—(Courtesy Weyerhaeuser.)

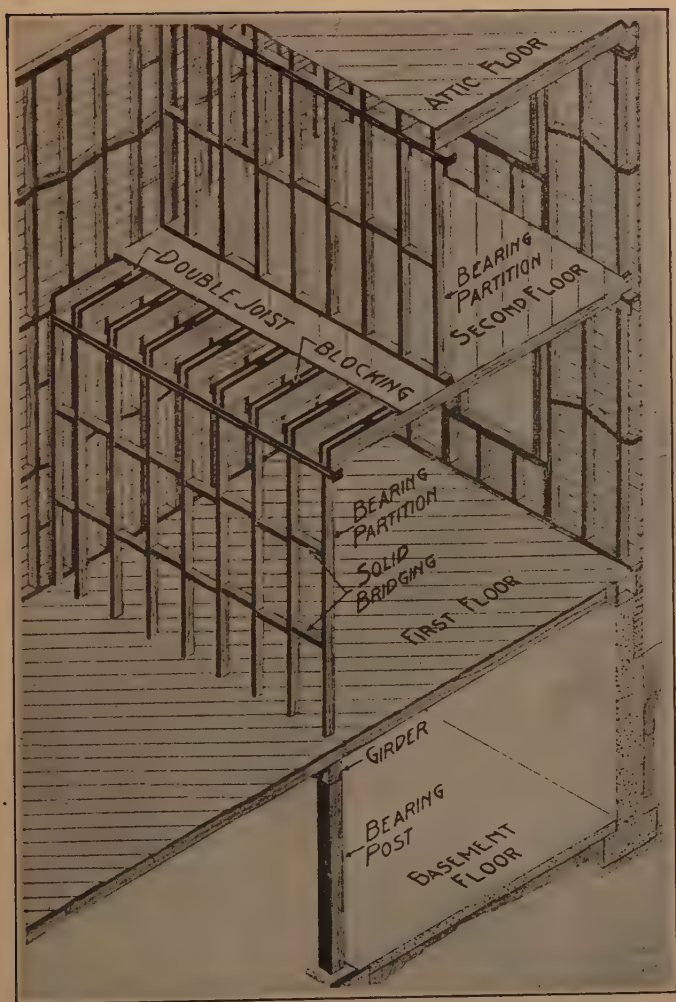
house with as low a moisture content as this, since, even though the lumber were dried to this state in the beginning, it would, during its process of building, absorb enough atmospheric moisture to bring it back to air-dry condition.

This additional shrinkage must therefore be taken care of in the manner in which the house is built. And this is rendered easy by the fact that lumber in drying shrinks mostly across the grain (in cross section) and only infinitesimally lengthwise (with the grain), making it necessary in designing the frame of a house merely to minimize and equalize as far as possible the amount of horizontal framing lumber appearing in cross section in the outside walls and bearing partitions.

In the properly designed house frame, then, the horizontal framing members in the outside walls and partitions—which are the only members in which wood in cross section is used, and so the only members subject to shrinkage—are minimized and equalized so far as it is possible without sacrificing the strength and rigidity of the structure. This may sound a bit complicated and involved, but reference to the accompanying drawings will clarify the matter.

In these illustrations proper and improper methods of providing for shrinkage in the improved balloon frame are shown. The same principle can, however, be applied to other types of frames.

Good builders everywhere are recognizing how easy it is to build against shrinkage and so are avoiding the numerous house ills that might otherwise result from the uneven settling of walls and partitions. Here, again, we have an illustration of how simple it is to see that one's house is substantially built, if one will take the trouble to study the working plans and then check up the various details as the house is being built.



While it is more economical, where possible, to have bearing partitions on all floors directly over the bearing posts and girders in the basement, this drawing shows how variations are effected.—
 (Courtesy Weyerhaeuser Forest Products.)

WALL AND PARTITION FRAMING

Obviously, the first essentials of wall framing are strength and rigidity, since the walls are required not only to carry a large part of the weight of the house, but must, as well, resist severe pressure from occasional high winds.

Wall and partition framing consists of studs, usually 2 x 4's, top and bottom plates and the necessary bracing and fire-stopping. Careful cutting, fitting, nailing, bracing and fire-stopping are all essential to sound, substantial walls and partitions.

There are two kinds of walls and partitions, bearing and non-bearing. A bearing partition or wall is one which runs at right angles to and supports the ends of the joists. In other words, a bearing wall or partition is one which bears or supports a load from above. A non-bearing wall or partition acts only as a screen or enclosure.

As has been pointed out, non-bearing partitions should be supported by double bridged joists. The studs which support the framing around stairways should also be doubled. Bearing partitions require special support when these partitions do not occur directly over the partition below. In such a case, the studs in the bearing partition below, which support this offside bearing partition, should be reinforced with two rows of bridging.

When a partition supports more than the weight of the roof and two floors, as in the case of a bearing partition in the basement of a two-story house, the studs in this bearing partition which, in such a case, replace the main bearing posts, should be not less than 2 x 6 or 3 x 4 inches.

In all cases bearing partitions should have double top plates and should be braced with solid bridging not less than 2 inches in thickness and not less than the full width of the studs.

The partitions in which the main soil pipe is placed require special framing as shown in our drawing.

WINDOW AND DOOR OPENINGS

It becomes necessary in the construction of the house to cut away part of the framing in the outside walls for door and window openings, and in the inside walls, or partitions, for door openings. Naturally this weakens the framework as a whole and the lost strength must be regained by reinforcing the framework around these openings. Failure to do so inevitably results in the sagging of the adjacent and overhead framing. This, in turn, will result in sagging and creaking floors, balky windows and doors and may cause joints to open in both the inside and outside woodwork.

REDUCING THE FIRE HAZARDS

The constant fear of fire prevails in all houses, especially those of frame construction. Yet, no matter whether the walls of a house are of stone or wood, the fire danger is always present; for let it not be forgotten that the walls, after all, form but a relatively small part of a dwelling. This is especially significant when the interior construction and the furnishings are borne in mind.

It is stated on good authority that 96 per cent of all dwelling house fires originate inside the house and that practically every dwelling house fire is due to carelessness or defects in the internal construction of houses. Defective electric light wiring, defective chimneys and flues, accumulated rubbish, overheated stoves and furnaces—these are but a few of the causes of dwelling house fires.

The house, irrespective of type, should be so constructed as to confine to a limited area any fire that might start within the house. This is done not by

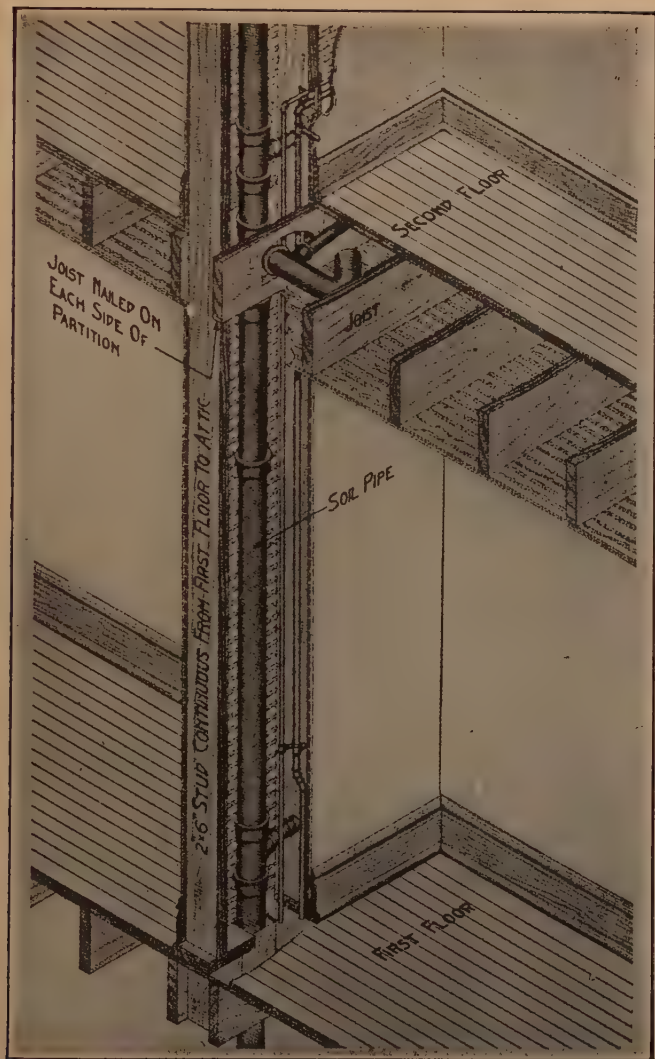
covering the outside walls and roofs with fire-resistant materials as many overzealous advertisers of fire-resistant materials would have us believe, but by the use of fire-stopping at the vital points within the frame of the structure—a matter of established practice among better builders throughout the country today.

To get a clear picture of the purpose of fire-stopping, the reader should consider, for a moment, a house that has none. If the plaster and lath were torn away from the inside of the walls of such a house, a series of open spaces between the wall studs would reveal themselves, these openings, in many cases, running from basement to attic. If the floors were removed, there would be found the same condition with the exception that here the openings run horizontally between the joists. In case of fire, these compartments act exactly as a series of chimneys or flues and actually aid the rapid spread of the fire throughout the house. For instance, suppose a fire starts in the basement near the wall. It soon burns its way into these openings and is carried up to the floors above, possibly to break forth simultaneously on every floor.

Fire-stopping dams these flue-like openings and thus confines the fire to one section, giving the occupants and firemen a much better chance to extinguish it. Considering the value of this work and the slight additional cost, what a surprise that it is ever neglected!

There are three methods of fire-stopping:

1. Two-inch lumber fitted in between the studs and joists.
2. The vital points boxed in with 1-inch boards and the boxes filled with incombustible material, such as loose mortar, concrete, mineral wool, etc.
3. Metal lath, bent and nailed into place between the studs and joists. The lath is then plastered and



Proper framing of the bathroom joists and plumbing is essential. Here is a suggestion, utilizing a strong partition for carrying these pipes and one which is not weakened by cutting and notching.—(Courtesy Weyerhaeuser Forest Products.)

the box thus formed filled with incombustible material.

Fire-stops are put into a building to prevent the passage of flames, hot air and gases. All joints should be tight, otherwise hot gases will pass through them and ignite the wood above. Poorly fitted fire-stops are little better than none.

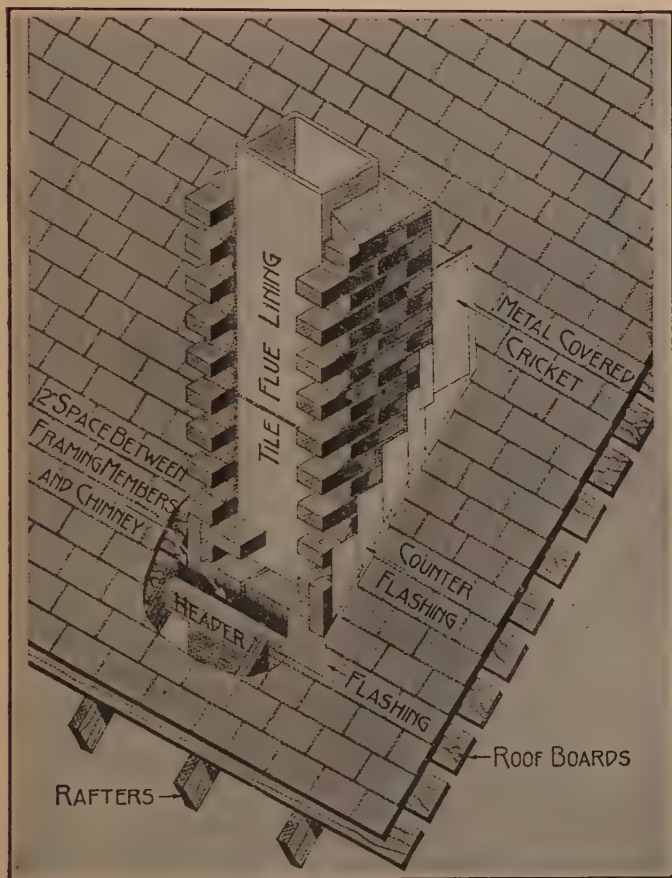
The slight additional expense involved in fire-stopping a house cannot rightfully be charged to fire prevention alone since much of it serves as bracing in the frame of the house. Fire-stopping more than pays for itself in the additional strength and rigidity it gives to the entire structure.

Thus it is seen that next to the elimination of the causes of fires, right construction is of first importance in increasing the fire safety in houses—nor can any house, regardless of its outside wall and roof covering, be considered a reasonable fire risk, unless fire-stopping is made an integral part of its internal construction. On the other hand, by proper appreciation of the points brought out in this chapter, it is possible today to build an all-wood house that will be in every way fire-safe.

THE CHIMNEY

The statement made a few pages back that a faulty chimney constitutes a fire hazard does not convey the full significance of faulty chimney construction. A poorly built chimney can be the source of much trouble throughout the house, even though it never causes a fire.

The purpose of the chimney is to carry off the smoke and fumes from the heating plant. Too many builders consider it as another prop for the house and a common practice is to fasten framing members to it. This is a bad practice for two reasons. The best chimney built will settle somewhat. If framing members are attached they must settle with it and sagging floors,



Construction of the brick chimney and how it is brought through the roof. Note the use of pieces of metal called "flashing," which serve to make a weather-proof joint between roofing and chimney. A properly constructed chimney should have tile or terra cotta flue lining, the mortar joints of which are well made and struck smooth on the inside.—(Courtesy Weyerhaeuser Forest Products.)

cracked plaster and the other evils of uneven settling are the logical result. Framing directly to the chimney also constitutes a fire hazard. Brick is not classed as a non-conductor of heat. As long, therefore, as we have combinations of zero weather, hot fires and framing attached to the chimney, our fire departments will have work to do.

The chimney, then, should be self-supporting and so constructed as to be absolutely independent of the house framing. First of all, it should have a good solid foundation. Soil conditions, of course, govern the size of the chimney footings, but they should never be less than 12 inches deep and should always extend at least 8 inches beyond each face of the chimney. The under surface of the footings should always be flat, not round or wedge-shaped.

The walls of a chimney with terra cotta flue lining should be not less than 4 inches thick if built of brick; nor less than 8 inches thick if built of stone. If the flue lining is omitted brick walls should be at least 8 inches thick, and stone walls at least 12 inches thick.

All combustible materials such as wooden framing members should be at least two inches from the chimney wall. The open spaces between the floor framework and the chimney should be filled with mortar, mineral wool or other incombustible material. Proper framing around the chimney is herewith illustrated.

While it is permissible, from the standpoint of fire hazard, to plaster directly on the brickwork of the chimney, the practice should be discouraged because plaster cracks are certain to develop. When plaster is applied in this manner, however, the furring strips placed around the chimney to support the base or other interior trim should be insulated from the masonry by asbestos paper at least one-eighth inch thick. A better practice is to box in the chimney with studs,

set two inches away from the brickwork, and on these to apply the lath and plaster.

It may seem superfluous to advise the builder to see that all smoke pipes are fitted tightly into the chimney, but the number of fires caused by lack of proper fitting of smoke pipes indicates that this work is frequently slighted.

The chimney should be capped with stone, terra cotta, concrete or cast iron and should extend at least three feet above a flat roof or two feet above a ridge roof. This lessens the danger of fires from sparks and assures a good draft for the heating plant.

Any increase in the wall thickness of the chimney should be made at least 12 inches below the rafters and not be made above the roof except for capping.

The common difficulties with chimneys are due largely to faults in their construction. They are entirely unnecessary in the light of approved methods of construction in use today.

The proper construction of fireplaces is fully described and illustrated in Chapter XV.

MAKING THE WALLS WEATHERPROOF

Many people are inclined to take for granted that a house is weatherproof until the vagrant, unaccounted-for drafts, the dust-streaked, water-stained walls and all too frequent trips to the coal bin bring forcefully to their attention the fact that theirs is not a weatherproof house.

The making of a weatherproof house, no matter what material is used for wall covering, starts with proper wall construction. If the joints around the doors and windows and at other points are not tight, good construction in the rest of the wall will not make the house cool in summer nor easy to keep warm in winter.

INSULATION

Insulation in the walls and roof of a house is now being widely recognized as a comfort maker and worth while money saver. While its use is not altogether necessary, it adds so greatly to the comfort and satisfaction of the occupants of a house that it is really becoming just as much of an essential in house building as it is in ice boxes or railroad refrigerator cars. It is especially valuable for climates where there are extreme variations in the temperature and where the thermometer reaches low levels.

The purpose of insulation is to retard the transmission of heat and cold, to seal the interior of the house and thus protect it from sudden changes in temperature. Modern insulating materials are composed of a large number of very small cells which amount to minute dead air spaces; therefore, they are very resistant to the passage of heat and cold. The house that is effectively insulated is warmer in winter and cooler in summer. What is more, it costs less to heat an insulated house; it is conservatively estimated that the saving in fuel will pay for the cost of the insulation in from three to five years.

Insulation can be viewed in one of two ways. It can be classed as a comfort-maker and as such is well worth the extra expenditure. If viewed as a fuel-bill saver it is an equally desirable investment.

There is no quicker way to defeat the purpose of insulation, however, than to apply it poorly. It must be fastened securely and must be used over the entire wall. Leaving a section of the house without insulation or failing to fit the material snugly at all points is on a par with protecting against the rigors of a sub zero night by tucking the bed covers in carefully at the sides of the bed and failing to do so at the foot.

The correctness of the principle of house insulation

has been so thoroughly demonstrated, and to insulate a house properly requires so small an outlay compared with the resulting comfort and economy, that it may be questioned whether any builder is warranted in building without it. It should be observed, however, that the mere use of insulating material does not always constitute insulation.

STORM DOORS AND WINDOWS

In those sections of the country where low temperatures prevail three or four months during the year, fuel bills can be materially reduced by the use of properly fitted storm doors and windows. The cost of this equipment also can be saved many times over during the life of the house through lower fuel bills.

METAL WEATHER STRIPS

Metal weather strips, when properly applied, prevent cold air from coming through the cracks around doors and windows, and thus effect a saving in fuel bills. In localities with extremely low temperatures and strong winds, the use of both weather stripping and storm doors and windows will be found most satisfactory, as well as most economical.

THE OUTSIDE COVERING OF THE HOUSE

Boxing, which is the first complete outer covering of the framework or skeleton of the house, should be shiplap if possible—that is to say, the boards used for the sheathing should have a lap feature so as to produce a tight wall. Only too often inferior boards are used for this purpose, since reliance is placed on the building paper and the siding or final outside covering for protection against the elements. The

sheathing should be nailed on diagonally rather than at right angles to the studding, as the former method gives greater rigidity to the entire frame. If the sheathing is laid horizontally, however, corner bracing should be used to give additional stiffness to the structure. The boards, with the lap feature or tongue-and-grooved, should be driven tightly together and nailed to each stud with at least two ten-penny nails in each board.

The principles of correct construction practice applying particularly to the framework of practically all houses is the same regardless of whether their outside covering be of wood, stucco or brick veneer. Upon good lumber, properly used, depends the ultimate success of the completed house.

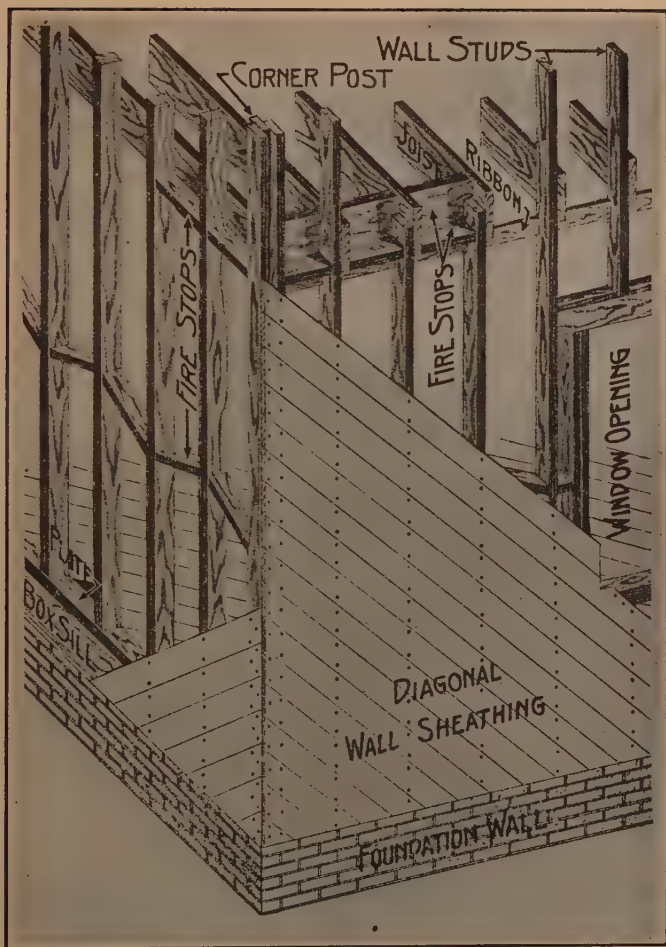
The selection of the material for the outside covering of your house will depend largely upon the amount of money you have to invest and to an extent also upon your selection of an architectural style. Certain styles of architecture suggest the use of some particular kind of material, for no one material is appropriate to all styles of architecture.

If you wish to cover your house with wood (and there are many good reasons why you would be warranted in every way in doing so) then your choice of that material will suggest a number of architectural styles to which wood lends itself more pleasingly and appropriately than any other material.

Nor are the styles adaptable to wood covering by any means limited to the so-called Colonial designs. The bungalow the Swiss chalet, the prairie style and many others are equally appropriate when built entirely of wood.

WOOD SIDING

For the outside covering of a house lumber is available in the form of siding cut to various patterns and



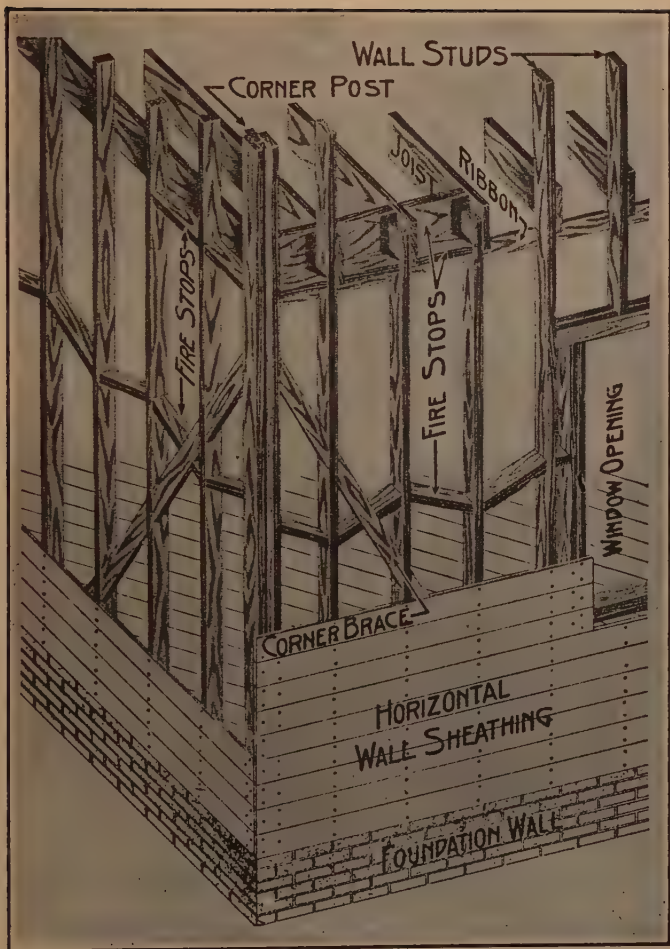
With the wall sheathing laid diagonally, a little more lumber is required, due to the slight waste in cutting, and also slightly more time. Such practice, however, adds materially to the stiffness and strength of the house.—(Courtesy Weyerhaeuser Forest Products.)

in various widths. Siding in 4 and 6-inch widths is available out of the regular stock of almost any retail lumber yard. Wider widths and special patterns may be obtained on special order.

The proper selection of the kind and grade of siding for outside wall covering is exceedingly important, for it is on the outside of a house, subjected alike to sun and wind, rain and snow, that the lumber receives its most severe usage. The wood should be of a decay resisting species, that will hold tight at the joints and that will take and hold paint. It should be thoroughly air-dry. The twisting and buckling of siding on a house or the all-too-frequent opening at the joints in outside woodwork are the result of faulty construction of the frame or improper selection of the lumber itself.

In applying the siding, all joints around the window frames and corner boards, or at the mitred corners, and splice joints should be carefully fitted. No splice joints in three consecutive boards should be directly over each other. Proper nailing is important. When 4 or 6-inch siding is used, each board should be nailed directly over each stud with 7-penny nails. Wider siding requires more and longer nails of the casing or cut steel type. The heads of these nails should be sunk into the wood for best results and the holes should be filled with putty up flush with the surface, after the first coat of paint is applied.

Siding and all other exposed woodwork should be given a coat of paint (the priming coat) as soon as it is in place. If it has been rained upon or has otherwise been subjected to moisture after having been applied, it should be permitted to dry out before being painted. It is highly important that a good grade of paint be used even for the first coat. It should be properly thinned to secure sufficient penetration.



With the sheathing laid horizontally as here shown, corner bracing should be used to give additional stiffness to the structure. The sheathing should be tongued and grooved or otherwise matched, and the boards tightly driven together.—(Courtesy Weyerhaeuser Forest Products.)

WALL SHINGLES

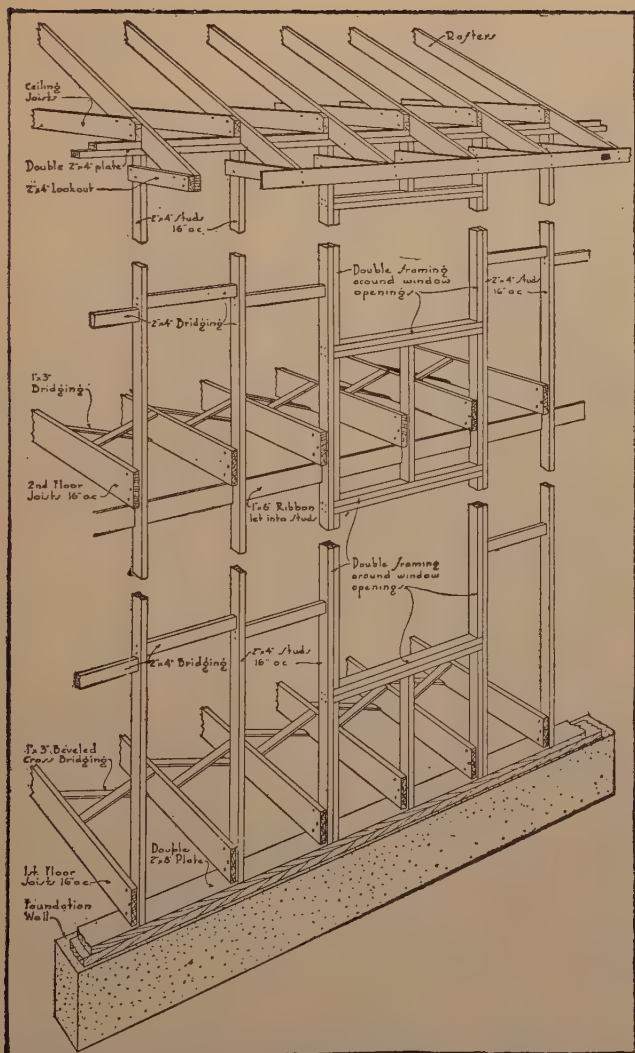
The choice of siding or shingles for wall covering is generally determined by the architectural design. The kind of shingles used are the same as those used on the roof and are laid in the same manner except that they are laid over tightly-matched wall sheathing and a wider exposure is permissible. Strictly wider exposure is permissible. Strictly clear 16-inch shingles may be laid as much as $7\frac{1}{2}$ inches to the weather; 18-inch shingles, $8\frac{1}{2}$ inches; and 24-inch shingles, $11\frac{1}{2}$ inches to the weather.

STUCCO

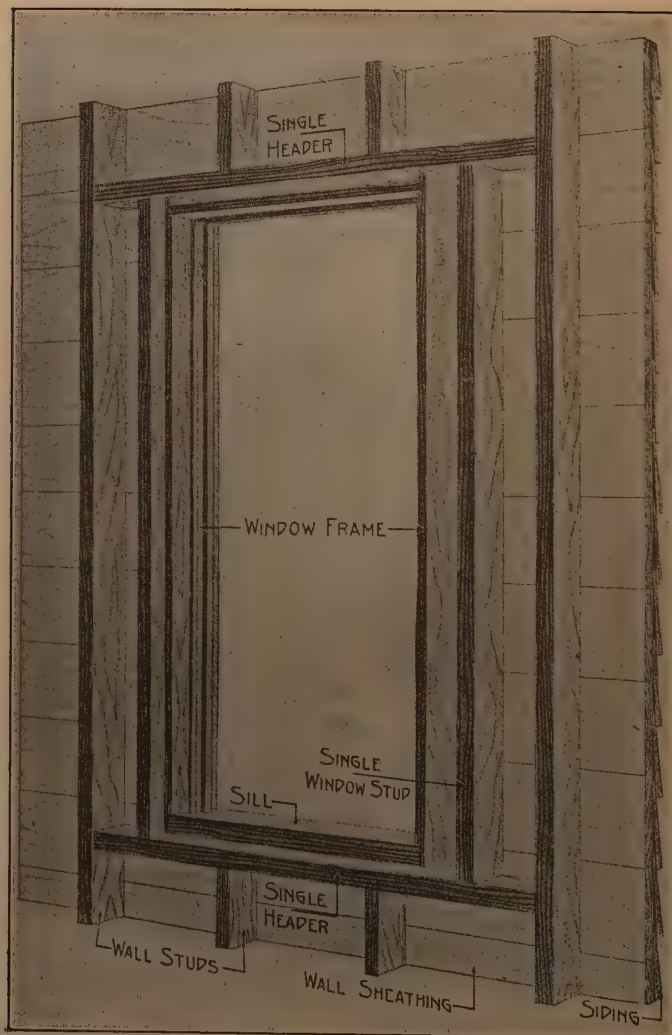
As has been said before, the misuse of material does not apply to wood alone. With the multiplicity of brands of stucco on the market and the numerous methods of applying it, this material involves some of the most difficult problems in present-day house construction. Cracked, falling and water-stained stucco are facts which cannot be overlooked by even the most casual observer. Just how to build against these evils, then, should be of interest to the prospective home-builder.

Proper application of the right kind of material, correctly proportioned and mixed, is essential to satisfactory stucco work. Of no less importance are the five following points:

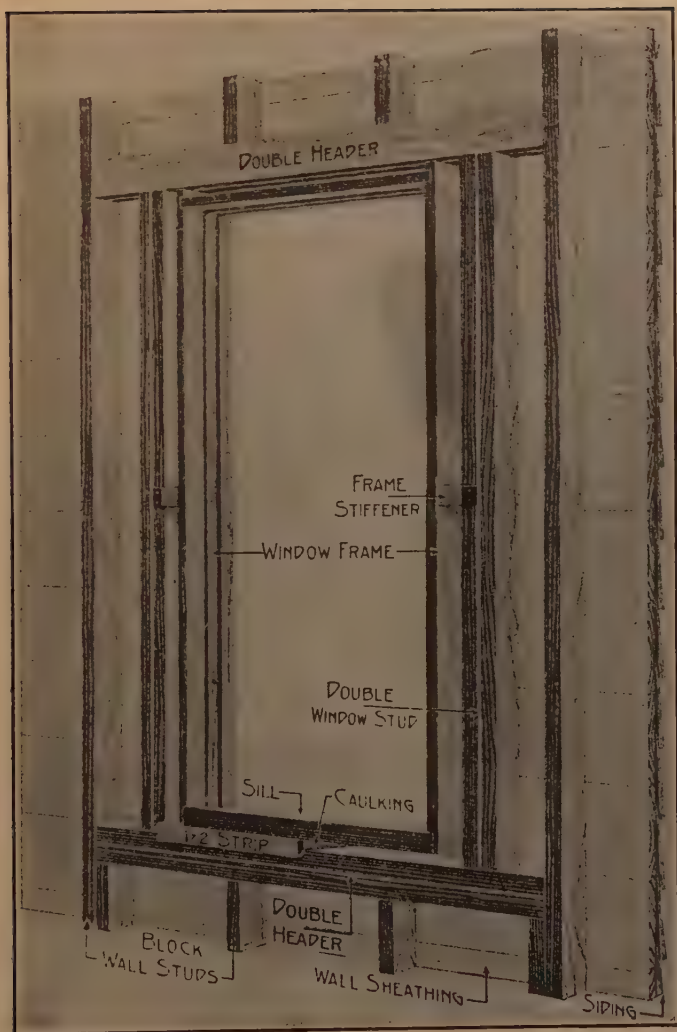
1. Stucco should not be run down to the ground. A solid concrete or brick base should extend at least six inches above the grade level.
2. The proper overhang and drip should be provided for all window sills and other horizontal wood-work. Some form of metal or wood stop should be provided at the ends to avoid the concentration of water over the ends of the sill. The tops of all win-



Suggested framing for taking metal lath and stucco. 2 x 4 inch bridging is used between the studs to reinforce the structure.—(Courtesy General Fireproofing Co.)



Improper method of framing around window openings. Single framing members have been used. They do not replace the strength lost in cutting away the studs to make the opening.—
(Courtesy Weyerhaeuser Forest Products.)



Proper method of framing around window openings. Note the frame stiffeners. These help to keep the window frame straight and eliminate one cause of binding windows.—(Courtesy Weyerhaeuser Forest Products.)

dow frames and horizontal panel strips, as in the case of the English half timber house, should be covered with flashing tin which should extend well up behind the lath and a quarter of an inch beyond the face of the panel strip so as to allow the water from above to drop off rather than flow down over the board and work its way behind the stucco where it joins the lower edge of the board.

3. There should be no horizontal surfaces of stucco on which water can collect. Liberal and discriminating use of flashing tin should be made wherever water might get behind stucco—such as the roof and wall intersection under joints of masonry, trim, etc.

4. When chimneys are to be stuccoed they should be covered with impervious caps to avoid unprotected stucco at the top of the chimney. Chimneys should be wrapped with metal lath before stuccoing.

5. Waterproof paper should be put on over the wall sheathing when stucco is applied to metal lath, and on the outside face of the studs when patent wood lath sheathing is used.

CHAPTER VI.

FABRICATED HOUSES—PORTABLE, SECTIONAL, AND READY-CUT TYPES

THE carpenter, sawing away and chipping away to fit the various pieces of lumber together into the frame of a house, does not belong to this advanced mechanical age. At least, so the case would appear at first thought. What with power saws and planers and joiners and other automatic woodworking machinery, it should be possible to do away with the major part of the manual labor connected with housebuilding. Obviously, such work would have to be done at a factory, but nevertheless it would do away with much of the tedious hand work and high cost of the usual construction.

This very thought is the basis for the fabricated house, in which the various components are cut to absolute size and perfect fit in a thoroughly equipped plant, and then shipped to the building site where they merely have to be assembled into a house, thus eliminating costly plans and uncertain building costs and all guesswork in actual construction. Thus the builder works with parts rather than raw material, and he becomes an assembler rather than a manufacturer.

THE THREE TYPES OF FABRICATED HOUSES

There are three broad divisions of fabricated houses,

namely, the portable house, the sectional house, and the ready-cut house.

The portable house is, as its name implies, a dwelling of such construction as to permit of ready erection and ready removal if necessary from a given site. No cellar or basement is provided in the case of the portable house, which merely rests on cedar, chestnut or locust posts. Strap irons are often supplied to secure the floors to the posts so that the heaviest gales will not move the building. Of course, a stone, brick, or cement foundation can be used to advantage, but a good post foundation will last from fifteen to twenty years. As a general rule the portable houses have single walls and are suitable for summer use only, although portable houses are also made with double walls properly insulated and sealed for all-year use.

The sectional house is made up of fabricated units manufactured at the mill, usually in three-foot or six-foot sections, these units being erected and bolted together at the site. Such construction makes for a permanent building and can be plastered in the regular way or lined with plaster board. Because of the greater amount of work involved in preparing the sections at the mill, the price of a sectional house is greater when bought, but considerable economy is effected in its erection since entire sections are assembled instead of mere pieces which must be fitted and nailed together.

The ready-cut house consists of standard building lumber prepared and cut to fit to form each part of the house with such mechanical precision that two houses can usually be erected in the time required to build one in the conventional cut-and-fit method.

THE PORTABLE HOUSE

The main purpose of the portable house is for summer use at the beach or mountain resort, although

dwellings of this type have also been employed as temporary living quarters during construction work on large engineering undertakings, in the war zone, in countries after an earthquake holocaust, and so on. Because of its small dimensions, the usual portable house is of the sectional type. The house comes in convenient sections, completely finished, which are readily handled by ordinary or unskilled labor. The doors and windows are hung complete, with all hardware, ready for immediate use. The outside walls are usually clapboard nailed to machine-dressed studs, presenting a finished appearance on both sides. They are interchangeable in the better offerings of portable houses, and fit together with patented lock joints. The interior partitions are of clean dressed boards to the plate line only. The floors are tongued and grooved, clean dressed boards, made in sections and battened on the underside. The roof sections are substantially framed and covered with boards, while sufficient crushed slate roofing is provided to apply after the sections are in place. The exterior finish is optional with the purchaser. If the building is painted white, round porch columns and a paneled front door are furnished in the case of one manufacturer. If rustic effect is desired the exterior is stained with a brown creosote stain—which is equal to two coats of paint—and rustic porch posts and battened door are provided. Shutters are furnished, ready to hang. The portable house may be erected on any kind of foundation, such as wood posts, brick or cement pieces or field stones.

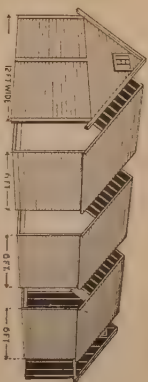
Aside from the sectional type, there is the ready-cut type, in which the house comes to the builder in the form of dressed and properly cut lumber ready to be assembled into the house structure. While the first cost of such a house is somewhat lower than the sectional type, it frankly does not pay in the long run

since the erection will require much more labor and time and the finished result is not apt to be as good, especially if good carpenters are not available for the work.

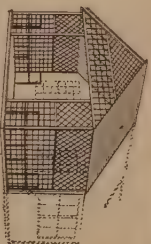
Then there is the unit system. One manufacturer of portable houses supplies his offerings in the form of units measuring 6 by 12 feet. Each section can be provided with windows and doors all fitted in place and painted with three coats of paint or stained, so that the builder has nothing more to do but to set up these sections and drive in wedge keybolts with a hammer. No skill is required, but when put together these units form a permanent and rigid building. Partitions can be used at any of the junctions of the six-foot units, thereby forming rooms 6, 12, and 18 feet in length. The opening is furnished with a curtain pole, but if a door is preferred it can be furnished. The end sections finish off the assembled sections to form the house.

The versatility of this unit system of portable buildings is truly remarkable. Thus the builder can obtain a screen porch unit at the same price as the regular units. Such a unit includes the screens made of galvanized netting. It can be attached to other units or used by itself. There are L units, measuring 6 by 7 feet running out from the main building. These units can be added at any of the junctions of the main house units or at the ends of the building. They are used for kitchens, bath rooms, small bed rooms, and so on. Then there are end clapboard porches, measuring 6 by 12 feet, ready to be attached to any of the other units. The floor is tight, and when the sides are screened such a unit is insect-proof. There are end latticed porches, measuring 6 x 12 feet and furnished with two seats, as well as clapboarded side porches and side latticed porches.

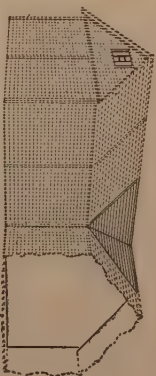
A variety of doors are offered for use in any of the



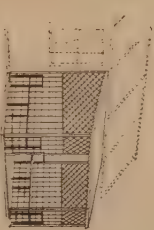
Blank Units (disjointed)



Lattice End Porch with Seat



Valley Roof Unit.



Lattice Side Porch



Dormer Windows



DW



CW



DCW



FD



SD



CD



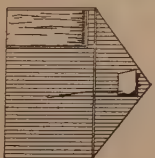
Clapboarded Side Porch



B W B



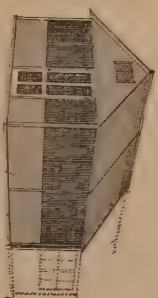
SRV



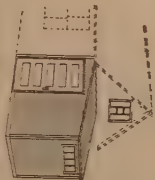
Partitions—See



Clapboarded End Porch



Screened Room Unit 12 x 12 ft.



En at end or side of house

The unit type of house grows with the demands of the owner. Units can be added or removed at will. Furthermore, because of the variety of available units, the architectural effects are rather interesting for a standardized house. Here are shown some of the available units, as well as windows, doors, shutters, dormers, and so on.—(Courtesy E. F. Hodgson Co.)

units, as well as a variety of windows. Valley roof units and dormer windows serve to break up the monotony of uniform units and make for attractive assemblies.

The unit system of portable house has its own particular field, especially where housing accommodations are desired in a minimum of time. Also, where ground is leased for a term of years, the unit system lends itself to ready and inexpensive erection, and to be taken down again to be moved to another site. Furthermore, it is ideal in cases where more and more space is to be secured from time to time, since, like the sectional bookcase, there is virtually no limit to the number of sections that can be added except architectural considerations and space limitations.

THE SECTIONAL HOUSE

When it comes to the sectional house, the construction is just a trifle more involved. Instead of starting out with completed units, we begin with sections of the house, such as the framing in sections, the sub-flooring in sections, the roof shingle lath in sections, the sheathing in sections, and so on, all designed to simplify the assembly of the house. In the case of one well-known make of sectional house, it is claimed that if a sectional house costs \$2,000, the buyer adds 10 per cent or \$200 additional for erection, plus delivery to the destination. This constitutes a building with all the carpenter work completed at a definite cost, leaving only the cellar, plumbing and heating, wiring, and decorations to be done locally.

Everything is done to facilitate the erection of the house. The carpenters in the field do not have to assemble hundreds upon hundreds of different pieces of material. They merely put these fabricated units together in accordance with instructions. On the aver-

age, there are approximately twenty times as many pieces to handle in building the old way as in building from fabricated or built-up units. The main beauty of this system of building is that the builder can go ahead on the basis of definite estimates of known costs. There is so little left in the way of details, such as foundation, excavation, plumbing, heating, wiring and interior decoration, that the cost can be determined pretty accurately in advance.

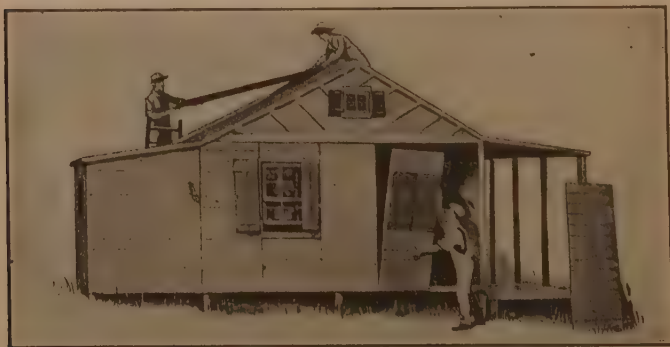
Under the conventional methods of building, the process of securing sketches and plans is slow and involved. Sometimes months go by before sketches and plans are worked out to the builder's satisfaction, and even then, there is no assurance that the finished building will be entirely satisfactory. With the sectional house, however, the builder can see photographs of the appearance of the proposed house, and can even visit such a house already erected.

Figuring material requirements the usual way is also a gruelling task. The estimator frequently underestimates, which means extra charges. The sectional house, on the other hand, affords a definite list of materials required.

Under the usual system of building, each house is not only built piecemeal, but it is prepared piecemeal. The lumber is assorted, surfaced, measured, and cut by hand methods. This means a waste of labor and material which is unavoidable. Hand methods of manufacture can never compete economically with machine methods. In the sectional house factory, on the other hand, machinery performs the usual carpentry work in a minimum of time. For instance, one machine surface joists on four sides and cuts them off true on both ends. Eighty joists, a number sufficient for one-story, six-room house, are prepared for erection in 10.6 minutes in the case of one factory. A mortising machine performs, in a quarter of a minute, work that

would require twenty minutes on the part of a carpenter.

Consider the one item of nailing. In the conventional method, after the material is cut, fitted and assembled, thousands of nails have to be driven by hand. Each is a separate operation, involving the driving of each individual nail with separate blows of a hammer. This is decidedly costly and wasteful of labor. On the other hand, nailing machines in sectional house plants now complete an operation in one minute that would require thirty minutes in the field with usual



The sectional type of house, in which the builder works with sections instead of pieces. Thus the framing comes in sections, the sub-flooring is in sections, the sheathing is in sections, and so on. This method of building is ideal for small houses.—(Courtesy Louis Bossert & Sons.)

methods. In one minute the nailing up of the storm siding for a wall section is complete and the section is ready for erection. Two men can erect it permanently in five minutes on the building site.

Inability to obtain the required materials promptly and completely has added greatly to the cost of many a building. Speedy erection is impossible, unless everything required is on the ground when needed.

Delays are doubly expensive of the non-productive hours of workers. On the other hand, prompt and complete delivery of materials is offered by sectional house manufacturers.

Coming down to actual building operations, the usual methods of building involve the cutting, mortising and fitting of the sills, girders, joists, studding, and so on, on the job—before erection actually begins. This means an endless amount of costly and not always accurate hand work—not to forget delays and waste of material. Meanwhile, speedy erection is possible with the sectional house. Plans are furnished in advance so the foundation is ready by the time the material arrives. The first floor decking is speedily completed. Fabricated sills and girders, floor joists and bridgings, furring, sub-floor sections and so on all come fabricated, surfaced and cut to size, ready to be instantly put together.

Constructing outside walls the usual way involves numberless operations. The sills have to be mortised, the scantlings, timbers, and plates have to be measured and cut, the wall frame erected and the sheathing put on. These multiplied operations, all done by hand, consume time and labor. In the sectional house the outside wall sections arrive fabricated—built up. Not only do these sections make for speedy and economical erection, but they also make for unusual strength because of the rigid construction.

Fabricated wall plates, fabricated gables, ceiling joists, ridge, rafters, collar beams, rafter cleats—all material for the upper part of the sectional house comes prepared for use, without waste and with accuracy which facilitates speedy erection. The roof comes in panels similar to the sub-floor sections. Putting these parts in place is a simple matter. When it comes to the inside details, we have the doors properly sized, mortised to receive lock, gained out, and ready

to hang. Interior trim comes bundled and marked for its proper place. Lath and plaster, as well as all necessary finish hardware, are furnished with each house.

THE READY-CUT HOUSE

The ready-cut house is built up from lumber cut to size and fit at the factory. It differs from the sectional house in that there is more work to the assembly, in that more pieces must be handled. Nevertheless, there is claimed to be a saving of 30 to 50 per cent in carpenter's time, and 17 to 20 per cent in lumber over the conventional method. One company manufacturing ready-cut houses recently conducted a test between the conventional method of building and the ready-cut method. The identical design was followed in both houses. The ready-cut house was completed in 352 hours, while the other required 583½ hours.

The main consideration in the erection of a ready-cut house is to pile and sort the material so that it is convenient for the workmen. The pieces are all marked, corresponding with blueprints, so that there is no excuse for mistakes. Thus all the 2 x 4's should be sorted out from the rest of the material, and they in turn sorted according to the lengths which have been marked on each piece, that is, all 16 ft. 2 x 4's in one pile and 3 feet in another, and so on. Then, when the workmen see that blueprints call for a 2 x 4 16 feet long, it is not necessary to go through the entire lot of material to find it.

To avoid trouble in erecting a ready-cut house, the workmen should not under any circumstances cut material intended for one place and use it in that of another. Plans should not be changed, or if the plans are changed, the builder should not expect the material to fit and work out as intended. All work is carefully laid out on blueprints and explained in clear, concise

instructions. The builder should never take anyone's advice as to how to build a ready-cut house. The manufacturer's instructions should be sufficient.

What has been said for the sectional house can practically be repeated here. The cost of a ready-cut house can be determined with more accuracy than the usual hand-made house, although not as accurately as the sectional house which starts out with units rather than finished pieces of lumber. Plans do not have to be sought and worked over and worried about. The various manufacturers of ready-cut houses are now offering highly attractive designs, and anyone can suit one's requirements and tastes from the catalogs of these manufacturers.

Whether to construct a sectional or ready-cut house is for the builder to determine. Contractors are often apt to be prejudiced against the ready-cut and sectional houses, while the laity, confounding such houses with make-shift portable dwellings of the crudest sort, have little confidence in these houses from lack of knowledge. The contractors generally base their prejudice on the fact that the average carpenter is not familiar with this method of building and is apt to become confused, using one piece of finished lumber for something for which it was not intended, thus throwing out of gear the entire building scheme. There is absolutely no excuse for such a performance, except crass stupidity.

During the war entire communities were built up with sectional and ready-cut houses. Contractors who have become familiar with ready-cut houses prefer them to the older methods of building. Large development companies have selected the sectional and ready-cut houses because of their economical construction, their enduring qualities, and their general all-round attractiveness.

But after all the prospective builder should study

his local conditions before deciding on the type of construction he will follow. If the local carpenters do not seem to understand sectional houses or ready-cut houses, it may be well to go cautiously. Many as the advantages are in favor of these types of houses, the fact remains that there is still something to be said for the old hand-built type of house.

CHAPTER VII.

THE BRICK HOUSE FOR PERMANENCE, BEAUTY, AND ECONOMY

THE use of brick in building construction dates back to prehistoric times. And the obvious fact that many brick buildings have come down through centuries of wear and tear bears witness to the lasting properties of brick construction. It is this lasting quality, together with negligible maintenance cost, which is the main consideration in deciding on brick. Then, when the present-day architectural possibilities of brick are borne in mind, as well as the strength and rigidity of brick, the slight additional cost of brick over other methods of construction becomes a secondary consideration.

THE COST OF BRICK CONSTRUCTION

According to the The Common Brick Manufacturers' Association of America, to whom the author is indebted for much of the information which appears in this chapter, up till recently there was but one type of burned clay construction that was fire-resistant and permanent—solid brick. A solid brick home ranges in cost from approximately the same as frame up to \$400 or \$500 more for an ordinary six-room house, according to the locality. But of late there has been

introduced an ingenious form of wall construction known as the Ideal wall, which is said to cost the same or even a little less than frame in any locality, and preserves all the good qualities of solid brick, while possessing advantages not known to any other construction. When it is remembered that the upkeep cost on some of the other types of houses may amount to as much as 21½ per cent of their cost every year, while the upkeep cost of a brick house may amount to no more than \$10. a year for painting frames and wood rafter ends on a small brick house, it will be realized that in the long run the brick house actually is more economical.

BRICK BONDS *

Bond in brickwork is the overlapping of the brick one upon the other, either along the length of the wall or through its thickness, in order to bind them together in a secure, structural mass. It is true, mortar is used to cement the brick together into a monolithic whole, but the real bond is the overlapping of the brick which the mortar serves to maintain. A glance at any brick wall will make this clear, as far at least as the outer surface of the wall is concerned. It will be seen that the brick instead of resting directly one above the other are shifted back and forth so that the vertical joints in two successive layers or "courses" do not come into line. We speak of this arrangement as breaking the joint.

In dealing with brick bond, two terms are constantly recurring, viz., "stretcher" and "header." When a brick is laid lengthwise of the wall, thus showing its long, narrow dimension or "face" on the surface, it is

* For the information that follows the author is indebted to the American Face Brick Association's book entitled "The Story of Brick."

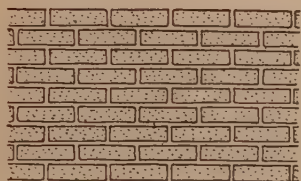


Fig 1. Running or Stretcher.

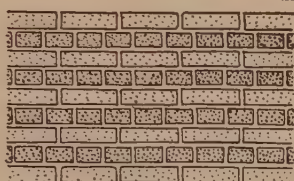


Fig 2. English.

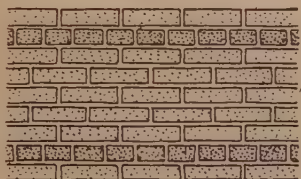


Fig 3. Common.

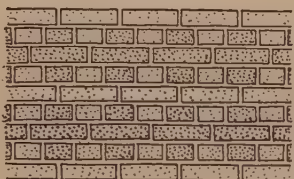


Fig 4. English Cross or Dutch.

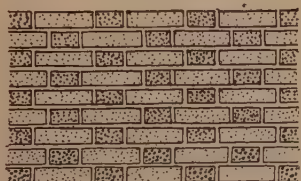


Fig 5. Flemish.



Fig 6. Header.



Fig 7. Garden Wall.

Various kinds of bonds or the overlapping of the brick one upon the other, either along the length of the wall or through its thickness, in order to bind them together.—(Courtesy American Face Brick Association.)

called a stretcher. If its length extends back into the wall so that its short dimension shows on the surface, it is called a header. The stretcher secures strength in the length of the wall. The header serves to form the transverse bond, that is, the strength of the wall throughout its thickness. When a brick is broken, as the case may require, the fragment is called a "bat." While at certain points of the wall these bats may be necessary, they should be sparingly used and then only according to the best practices of the craft.

In the old days, and indeed up to comparatively recent times, brick bond was used only structurally, that is, to secure strength of the wall as a solid mass, but in the seventeenth century European builders began to see an artistic possibility in the bond as it appeared on the surface. They began to see the fine tracery of the mortar joint running over the background of the brick, which could be varied into attractive patterns by different arrangement of the brick bond. As a consequence, there have been developed, in the main, three different types of bond which are used at the present day, with various modifications, to secure attractive effects in pattern.

The first and most obvious of these bonds is what is called *Running* or *Stretcher* bond, shown in Fig. 1 of the accompanying drawing. The wall surface is made up of stretcher courses, having at the corners a header which appears as a stretcher on the return side. This bond has the merit of being very strong longitudinally, but lacks transverse strength; consequently, it is modified into what is called *Common* or *American* bond by laying a course of headers every sixth course, Fig. 3. As a type of *Running* bond, headers instead of stretchers may be used (Fig. 6). As this bond is very slight, it should not be laid except for panels or other ornamental effects. The headers may also be laid without

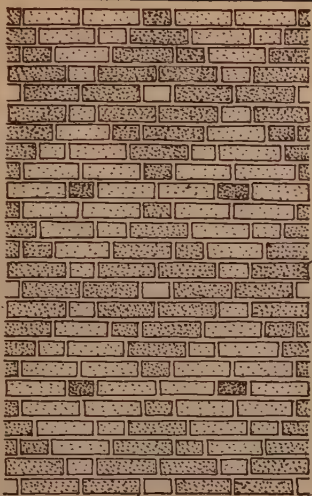


Fig 8.

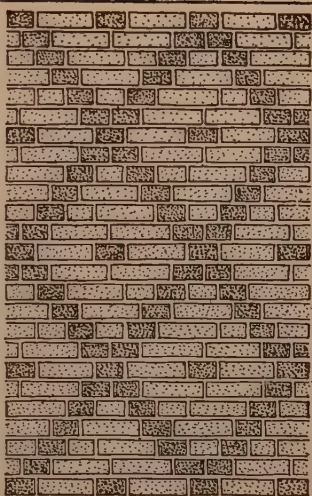


Fig 9.

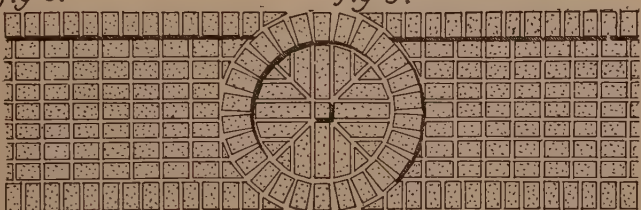


Fig 10.



Fig 11.

Face Brick Patterns

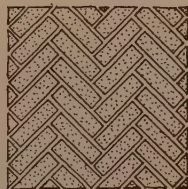


Fig 12.

Additional kinds of bonds, as well as face brick patterns. Through the selection of attractive bonds it is possible to obtain highly pleasing effects from brick walls.—(Courtesy American Face Brick Association.)

any bond at all (Fig. 10), in order to secure a reticulated or checkerboard effect.

The method of using headers, as in Common or American bond, in order to secure transverse strength of wall, can be treated in a way to produce very much more pleasing effects, as may be seen in the *English* and *Flemish* bonds. The English bond is made up of alternating courses of stretchers and headers (Fig. 2). This produces a very pleasing series of Greek crosses and ripple lines up and down the surface of the wall, and the English brick builders claim for it the great merit of giving transverse strength to the wall. It, however, has a certain monotony that has lead to a modification which greatly beautifies it as a pattern, by breaking the joints of the successive stretcher courses. This is called *English Cross* or *Dutch* bond (Fig. 4) and results in a very attractive pattern in the wall of Greek crosses running in diagonal lines. The Dutch bond differs from the English Cross bond only in the way the corners of the wall are treated.

The *Flemish* bond (Fig. 5) is secured by laying each course in alternate stretchers and headers, the header resting upon the middle of the stretcher in successive courses. This produces a most attractive pattern of dovetailed Greek crosses and is a favorite among builders because of its artistic effect. It may also be modified in various ways so as to produce different pattern effects. Thus the *Garden Wall* bond, so called, (Fig. 7), is made by laying the courses with from two to four stretchers alternating with a header.

PATTERNS IN BRICK WORK

With these three fundamental bonds—the Running or Stretcher, the English and the Flemish, innumerable other patterns may be made by the simple device of shifting the stretcher or header in successive courses

back and forth, always breaking the joint, that is, never permitting two vertical joints to come in the same line. Thus in Fig. 8 the diamond pattern is secured by a modification of the Garden Wall bond. It is however, only in case of large wall surfaces that patterns of an elaborate character could be recommended; ordinarily, the three bonds mentioned, with their simplest modifications, will cover all requirements of domestic architecture.

In addition to bonds proper and the patterns that may be woven out of them, there are certain pleasing ornamental effects that may be secured in the wall surface by the arrangement of the brick. Thus for a water table or a sill course the header or the stretcher may be set vertically. Treated in this way headers are called "rowlocks" (Fig. 10) and stretchers "soldiers." For dadoes and friezes or for paneling, especially on large surfaces, patterns of a simple or ornate design may be used (Figs. 8 and 12). Figs. 11 and 12 are good hearth or garden walk patterns. All designs may be greatly modified and enhanced by the arrangement of the brick color tones as suggested by the shading in Figs. 8 and 9.

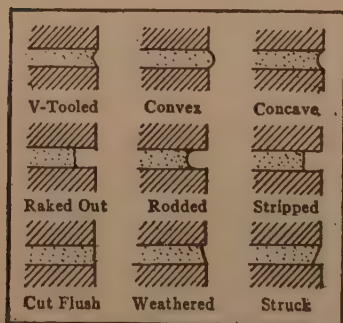
MORTAR JOINTS

In examining the bond in a brick wall the eye naturally is first attracted to the brick units as so many colored spots in different pattern effects; but this pattern effect in the brickwork depends very largely upon what at first may be overlooked or disregarded, the mortar joint. The mention of mortar suggests a very commonplace thing which the workman mixes and carries in a hod to the bricklayer, but it is one of the most important elements entering into the beauty, as well as the strength, of the brick wall. When one considers that all the joints in brickwork, both vertical

or "head" joints, and horizontal or "bed" joints, are filled with mortar of one color or another, amounting on an average to one-seventh of the wall surface, it is evident what a vital part they play in the appearance of the entire wall surface. An artist will tell you that this amount of color introduced into any surface will greatly modify, by contrast or analogy, the general effect, so that it is of the utmost importance, in selecting the sort of brick one wishes for a wall surface, that one also select the mortar joint.

Three elements must be considered in dealing with the mortar joint: its color, its texture, and its size and kind. The color of the mortar joint may be such

as entirely to destroy the beauty of the brick. On the other hand, if it is properly chosen, it will bring out the fine shades and tones of the brick in such a way as to enhance very greatly their natural beauty. Then, the mortar joint has a certain texture which is produced either by finishing it rough or smoothing it with the trowel or a tool made for that purpose. This mere treatment of the surface of the mortar



There are various kinds of mortar joints which, in conjunction with the bonds, make for attractive effects.—(Courtesy American Face Brick Association.)

joint has more to do with the appearance of the wall than one might at first suppose. In addition to that, the size of the mortar joint, running from a thin "battered" joint up to an inch, naturally affects the color relation of the whole surface; and the kind of joint, whether cut flush, raked out, or tooled in various

shapes, has a distinct bearing on the whole effect. Never decide on a mortar joint until you thoroughly talk it over with a face brick salesman. He will have valuable suggestions to make. In a word, do not neglect the mortar joint, for it is one of the most important elements that go to make up the beautiful fabric of the brick wall, in the building of which there is deserved and required the exercise of the very best taste.

All in all, what with the convenient units of stretcher and header, each with its color and texture, you may, in the choice of bond, mortar joint, and pattern, weave the most charming mosaic or tapestry effects in the wall surface, a possibility offered by no other material than face brick.

THE IDEAL WALL *

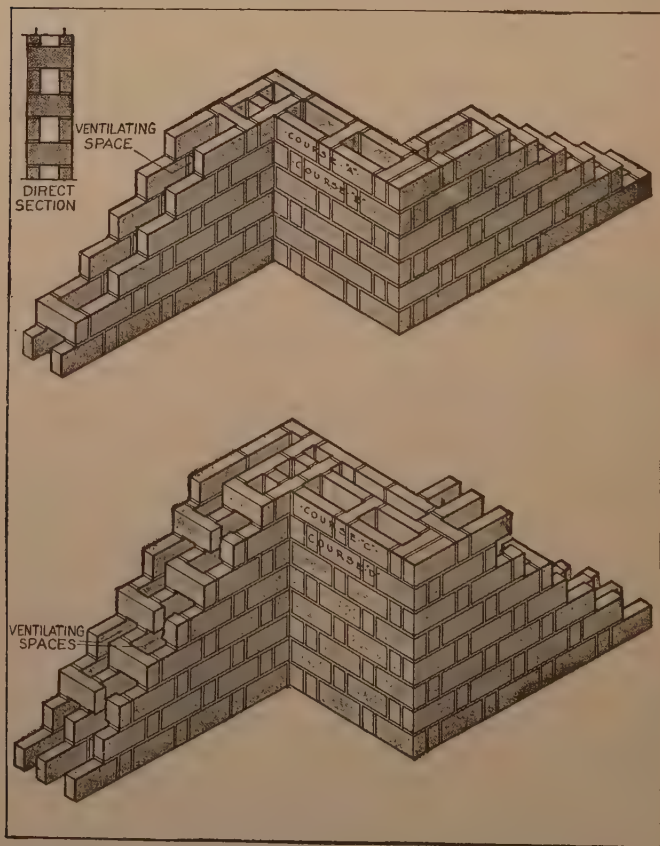
So much for solid brick construction, involving the use of face bricks for the prettiest results. We now come to cost-saving methods in brick wall construction. The Ideal wall is the name given to a new type of brick work which makes use of standard brick and produces a substantial and well insulated wall of any thickness from 8 inches up, at a cost which is claimed to be less than any other type of construction.

The Ideal wall has the marked advantage of a considerable saving in both materials and labor, combining the advantages of the solid brick and hollow unit types of wall at a lower cost than either, so claim its advocates.

There are two types of Ideal wall: first, the Ideal

* For the balance of the material in this chapter the author is indebted to The Common Brick Manufacturers' Association of America.

all-rolok wall, in which all the brick are laid on edge; secondly, the Ideal rolok-bak wall in which the brick in the outer 4-inch course are laid on their flat bed,



The eight-inch and twelve-inch Ideal walls, in which common brick are used to obtain a well-insulated wall at a surprisingly low cost.—(Courtesy The Common Brick Manufacturers' Association of America.)

so that the wall has the usual brick appearance, the backing brick being on edge. Header courses may be run at every third or every sixth course and any bond may be used.

It will be noted that the Ideal wall has an absolute, positive break in the mortar joint in the direction of the thickness of the wall, thus accomplishing with ordinary brick what has long been striven for in vain through the use of special shapes and units which lack many of the good qualities of brick and are not as convenient to use.

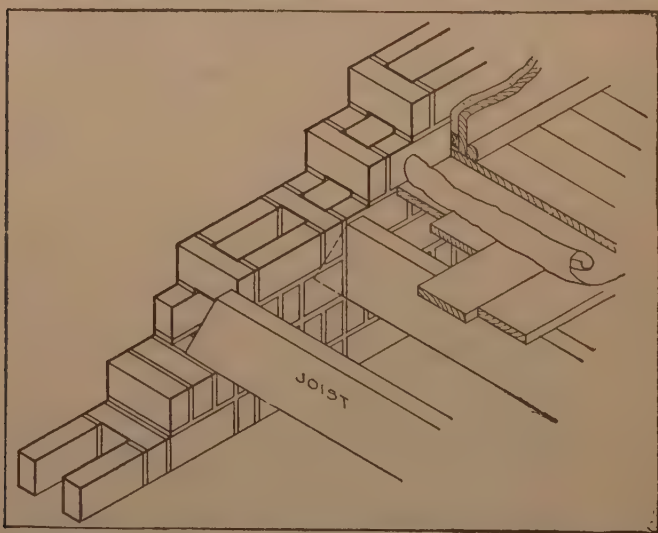
In a wall above grade it is almost impossible under conditions existing in actual practice, for well burned header to carry moisture along its entire length by capillary attraction. Moisture can, under severe conditions, be conducted along a mortar joint either of cement or lime mortar; hence the importance of interrupting the joint. The 8-inch Ideal wall has one break in the mortar joint and the 12-inch wall has two.

To safeguard further the inside surface, a slight steady circulation of air in the cavity dries out any small amount of moisture that might reach the portion of the header within the hollow space. The 8-inch wall has one ventilated space, while the 12-inch wall has two.

No special sizes or shapes of brick are required for the Ideal wall. Standard sized brick only— $2\frac{1}{4}$ by $3\frac{3}{4}$ by 8 inches, either face or common, are used. Greater speed of construction is possible when a non-pervious brick is used for Ideal wall construction. The use of shale or similar hard impervious brick slows down the work where the brick are laid on edge. The use of non-impervious brick is also advisable for the reason that such brick make the most weather resistant wall in Ideal construction. It will readily be seen that during a very heavy and long continued downpour of

driving rain an absolutely impervious header might conduct a slight amount of moisture along its surface toward the inner face of the wall, whereas a header of non-impervious brick would absorb this moisture, which would be dried by the slight steady circulation of air within the hollow space.

From many parts of the United States users report that plaster applied directly to the inside brick surface of properly built Ideal walls—without the use of furring—has proved satisfactory, and that with walls so



Construction with the Ideal wall, showing how the joists are supported in the wall.—(Courtesy Bureau of Standards.)

constructed buildings are warm, dry and comfortable. With any kind of construction there are, of course, factors beyond the control of the material manufacturer and which affect the properties of the finished

structure. Supplementing the brick, there must be also reasonably good mortar and workmanship, and where such are used it is the belief of authorities, based on a remarkable record of satisfactory performance, that furring may safely be omitted with the 8-inch ideal wall and the plaster applied directly to the inside brick surface, excepting in those parts of the United States which have long continued periods of severely cold weather, such as northern Michigan, the Dakotas, and Montana, in which localities the 8-inch wall should be furred to provide additional air space, or the 12-inch unfurred Ideal wall used instead.

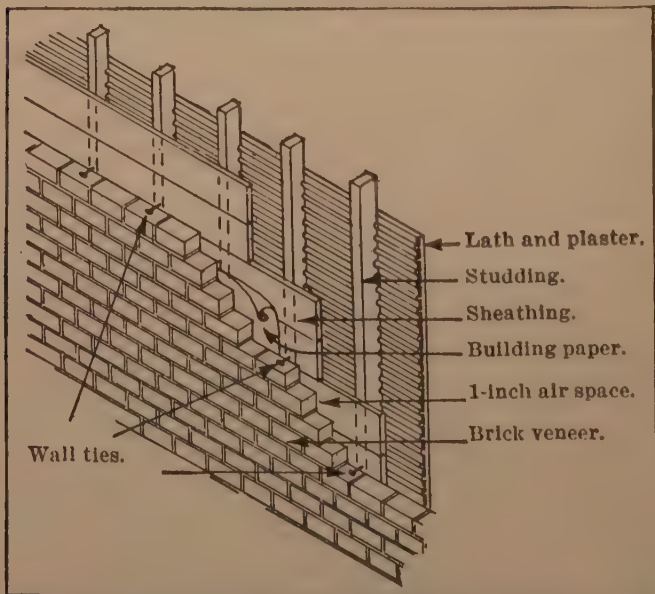
Local ordinances govern permitted wall thicknesses in various localities. In their absence the following safe minimum thicknesses may be followed:

Above the first floor line the 8-inch wall is recommended for enclosing walls of two and one-half story residences, residential buildings (such as apartments or club buildings) or other buildings having similar light floor loads and in which story heights and unsupported lengths of wall are not excessive. For three-story buildings similar to those above described, the first story should have a $12\frac{1}{2}$ inch wall and an 8-inch wall above and for four stories the first and second story walls should be $12\frac{1}{2}$ inches, and 8 inches above.

For resisting earth pressure, basement walls for residences, whether the superstructure is brick, frame, or any other material, should ordinarily be $12\frac{1}{2}$ inches thick. Where the basement is shallow, or the soil dry and gravelly or of such consistency that earth pressure will not be excessive, basement walls for residences up to two and one-half stories high may, under favorable conditions, be built eight inches thick if of brick. A $12\frac{1}{2}$ -inch Ideal basement wall is sufficiently strong under ordinary conditions for buildings classified above, four stories high.

BRICK VENEER ON FRAME

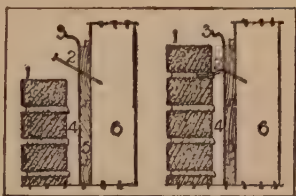
In many cases it is possible materially to improve an old frame house by veneering it with a shell of 4-inch brickwork. The brickwork undoubtedly adds to the life of the house and "paints" it with an enduring surface that does not have to be renewed. Old frame



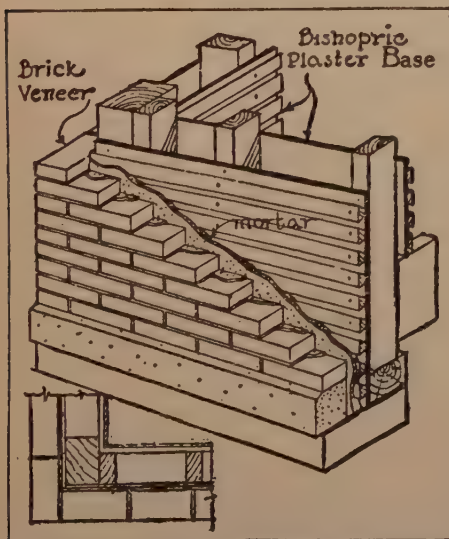
Brick veneer wall, in which the usual frame construction is employed to support the house, while a single-thickness brick wall is used for a mere coat, so to speak.—(Courtesy Bureau of Standards.)

houses were generally built more sturdily, with larger timbers, than frame houses built today, and with their foundations they can often be relied upon to support the weight of the veneering.

It is held to be a mistake, however to construct new buildings of brick veneer on frame. One of the great advantages of brick construction is the permanence and fire resistance of its walls, qualities which are lacking in brick veneer. Upon a frail skeleton consisting of the usual studding, which is only too often subject to shrinkage, is placed the heavy duty not only able of supporting the dead and live loads



Fastening brick veneer to frame backing: 1—Face brick. 2—Wall ties. 3—Tar paper. 4—Air space. 5—Sheathing. 6—Studding.



Another method of applying brick veneer, this time making use of Bishopric stucco base for the sheathing, as indicated.—(Courtesy Bishopric Mfg. Co.)

of the house, but there is also tied to it a weight of several tons of brickwork built so that its stability is negligible. Especially when a wind is blowing the resulting racking and straining is a tax on the strength of the framework. In a wall of sound construction the entire wall should act as a unit in bearing loads and resisting stresses.

A fire starting in a veneered house burns up not only the inside of the house, but the wood part of the outside walls; and the collapse of the brick shell upon the ruins is almost certain. With the brick veneer[†] house the lower insurance rate of the real brick house is forfeited.

Then, too, brick veneer costs more than a solid or Ideal brick wall in any part of the country. Especially since the advent of the Ideal wall, there are no good reasons for using this thoroughly unsound type of construction, which is both a deception and a snare.

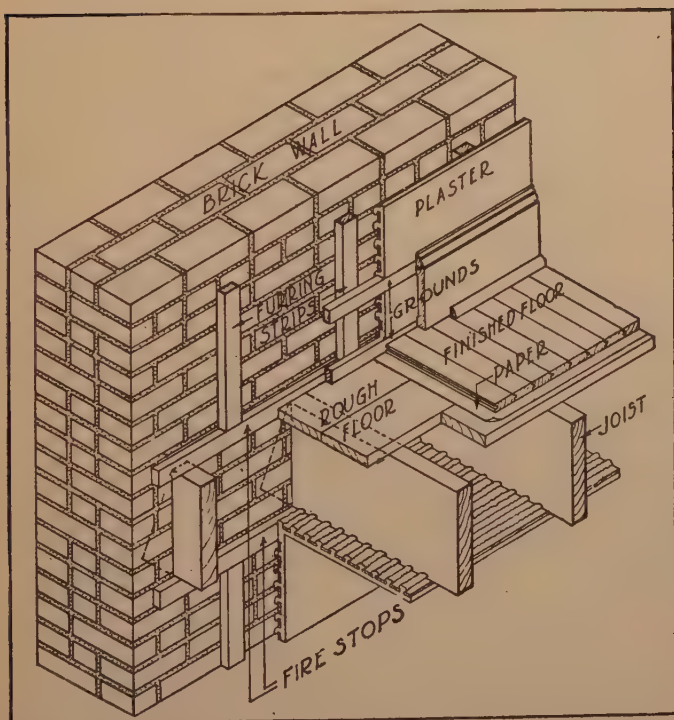
BRICK COVERED WITH STUCCO

Stucco is plaster in various surface textures applied to exterior walls. In its natural state, however, cement finish is dreary and lifeless compared with the rich sparkling effects produced by exposing the brick.

A house finished in stucco placed upon a base of any construction cannot compete in price with the Ideal wall, with its beautiful everlasting brick surface; and in many localities the solid wall furred compares very favorably in price with the stucco house. It should be noted, however, that the price of the latter varies considerably according to the nature of the construction behind the stucco; and the fire resistivity and permanence of the underlying construction should always be carefully considered.

Inasmuch as the Ideal wall is the lowest in cost of any wall that can be constructed, it is suggested, if stucco finish appears desirable, to obtain bids upon this finish placed upon the Ideal all-rolok wall built with the lowest priced brick. Providing that all the headers, and the stretchers in the outer web, are fairly hard burned, even "cull" brick are entirely suitable for this purpose.

Stucco is a somewhat unreliable finish, however, in-



Solid brick construction, making use of furring strips and plaster to ensure against dampness, and introducing fire-stopping of furred masonry wall at floor and ceiling.—(Courtesy National Lumber Mfrs. Asso.)

asmuch as its durability depends on the degree of its adhesion to its base, and there are many instances where stucco has disappointed owners by its tendency to peel away. If a stucco finish is specially desired, a brick surface with joints left rough is far superior to any other building material yet devised as a base upon

which to place it. The surface of the brick itself is of a nature that enables the stucco to bond into it, if well wet when the latter is applied, and if the joints are left rough a mechanical "key" is also provided, and brickwork, of course, never shrinks.

CHAPTER VIII.

THE HOLLOW-TILE HOUSE AND THE STUCCO HOUSE

NOT alone because of its permanence but because of its attractive appearance, the stucco house of late years has been steadily gaining in popularity. Time was when the stucco finish was confined to the plain gray cement finish, which, truth to tell, is rather monotonous in big pieces. Today, there are available various special stuccos of attractive hues, as well as special finishes which give the stucco coat a beauty all its own.

THE STUCCO SUPPORT

Too often the layman considers the stucco house in terms of a masonry construction. He is possessed of the idea that the stucco house is surely of hollow-tile construction, or, more likely still, that it is of poured concrete. Little does he realize that stucco is merely a coat, and that underneath the stucco may be hollow-tile, brick, concrete block, stone, metal lath on wooden framing, or special sheathing on wooden framing. As often as not the stucco is merely the coat for a frame house, and is used in place of shingles or clapboard. Stucco produces an excellent house, although in all fairness it must be evident that a hollow-tile house

with stucco finish is something quite different from a frame house with stucco finish.

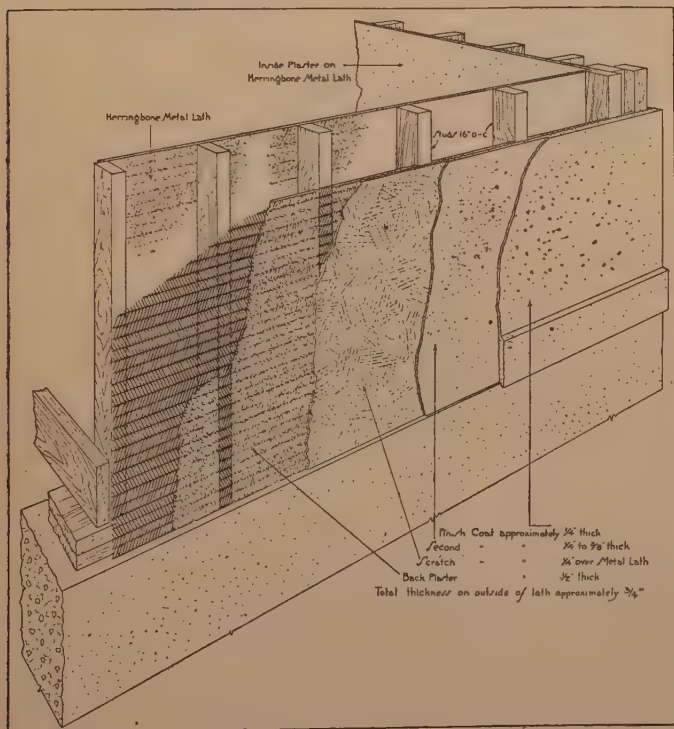
Portland-cement plaster, as distinguished from lime or gypsum plasters, is one in which the binding material is largely or wholly Portland cement. Cement-plaster, because of its resistance to the action of water, is particularly adapted for use wherever excessive dampness occurs and for all exterior work which is exposed to extreme weather conditions.

Now the most extensive use of cement plaster, aside from underground construction, is in the form of "stucco," which is the general term for any kind of plaster applied to the exterior of houses or other buildings. The stucco house is rapidly becoming a very common type of resident construction, especially in the suburban districts of large cities; hence, a brief enumeration of the advantages and disadvantages of stucco construction will be of interest to prospective home builders.

As already mentioned, there are several different types of construction on which stucco exteriors are used, the most common being the frame house in which the outside walls are sheathed with boards laid diagonally, then covered with tarred felt or sheathing paper. Over this foundation, wood or metal lath is applied, which supports the outside coating of stucco. Reliable figures show that this type of house costs on the average from 2 to 5 per cent more than the same type covered with clapboards or weatherboards, and has the very decided advantage of being better protected from neighboring fires and of costing less for maintenance.

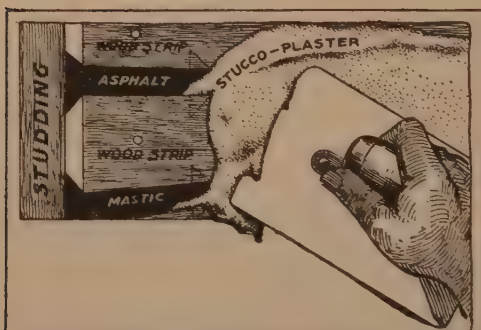
A modification of the foregoing type is one in which the outside sheathing is omitted, metal lath is fastened directly over the studs, and the stucco is applied to both sides of the metal lath before the interior is lathed and plastered. This type costs about the same as that

in which the sheathing is used and has the advantage of a heavier cement coating, which insures the protection of the metal from rust. The frame of such a



Standard back-plastered stucco construction on herringbone metal lath without sheathing boards.—(Courtesy General Fire-proofing Co.)

house requires special bracing, and it is advisable also to have insulating felt put into the outside walls, but these features add comparatively little to the cost, and



How stucco or plaster is applied to the Bishopric interlocking dovetailed key strips.—(Courtesy Bishopric Mfg. Co.)

a house so constructed is one of the best that can be built at a cost of \$3,000 to \$5,000.

In frame houses with stucco exteriors both wood and metal lath are widely used. Wood lath is cheap-

er, and some wood lath has the disadvantage of expanding and shrinking with changing moisture conditions, and many cases are known where this defect has resulted in the fall of large sections of the exterior coating. The main disadvantage of metal lath is its liability to corrosion, with consequent destruction of the plaster coating. This defect can be overcome by the use of galvanized lath well imbedded in cement plaster. Especially in the back-plastered type of house, described in the preceding paragraph, the possibility of the lath rusting seriously is remote.

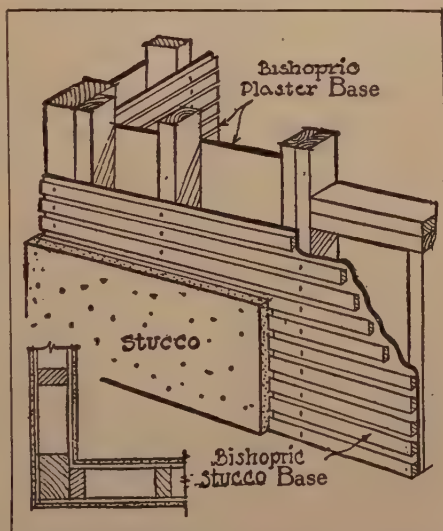
Stucco is also applied to houses built of brick, concrete block, and hollow terra-cotta tile. In such construction the stucco is mainly for decoration rather than protection, interior conditions being largely independent of the condition of the stucco. Houses of this type are better than frame houses, being generally warmer in cold weather, more nearly fireproof, and costing less for maintenance and insurance. The first cost is, of course, somewhat higher than for frame construction.

THE TENDENCY OF STUCCO TO CRACK

All stuccos are liable to crack from various causes, and probably all do crack to a greater or less extent. The durability of plaster and stucco construction was the subject of an extensive investigation undertaken by the Bureau of Standards in 1915, the first step being the construction of a test building containing 56 large exterior panels representing practically all of the common types of stucco construction. Of these 56 panels only two have been found to be entirely free from cracks, although many are practically uninjured by the cracks which have thus far developed.

In the case of frame stucco houses extensive cracking may result in damaging the interior, as well as detracting greatly from the external appearance; in the case of brick, tile,

or concrete base the cracking of the stucco is generally an injury only so far as it affects the appearance. As cracks of any sort are much less prominent on a



Simple and inexpensive form of wall, composed of Bishopric plaster base and Bishopric stucco base on frame.—(Courtesy Bishopric Mfg. Co.)

rough surface, the rougher finishes are to be recommended for stucco houses; for example, the "pebble dash" or "rough cast" surfaces, in preference to the smoother finishes as ordinarily given with trowel or float.

There is much difference of opinion as to the best mixtures to use for exterior stucco. Perhaps that most commonly recommended is a mixture of 1 part cement, $2\frac{1}{2}$ parts or 3 parts of sand, to which is added about $1/10$ part of hydrated lime, by weight of the cement. Mixtures containing even more sand are recommended by some; others advocate the use of straight cement-and-sand stucco; still others favor high-lime stuccos, that is, the mixtures containing more lime than cement. Up to the present time it has been impossible to get reliable comparative data on the durability of different stuccos. Many variables enter into the problem, such as weather conditions and workmanship, which are rarely recorded, yet which undoubtedly contribute largely to the durability of this type of construction. Moreover, stucco specifications are rarely followed exactly unless the work is under constant supervision, because plasterers are inclined to use their own judgement in developing easy-working mixtures, which are not necessarily those designed to give best results.

Fortunately, there are various prepared stuccos on the markets, which have been carefully worked out for the very best possible results in this kind of work. Some of these stuccos are obtainable in attractive colors, such as rich browns and warm buff. These stuccos are generally put up in specially made heavy, waterproof bags containing 100 pounds each, already mixed and available for immediate use. The stucco generally requires about four gallons of clear water for each 100 pounds.



Large frame building with Bishoprie stucco base in place, ready to be stuccoed. This makes a most attractive type of building at a very reasonable cost.—(Courtesy Bishoprie Mfg. Co.)

Of the various finishes that may be obtained, the dry dash is more beautiful and preferable to all others. It is produced by casting clean dry aggregate of various kinds into the finish or second coat of stucco while it is soft. A combination of white or colored marble chips—gray, green, red or pink granite—and pebbles of different colors are used for this purpose. By combining or mixing different dash materials, many delicate and strikingly beautiful color effects may be secured. Combinations to harmonize with any desired architectural treatment may be obtained by mixing dash materials of desired color. These are nature's colors and they never fade. Aggregates, which are small pebbles and chips of stones and rock crystals, are obtainable in different color effects and milled sizes for any desired effect.

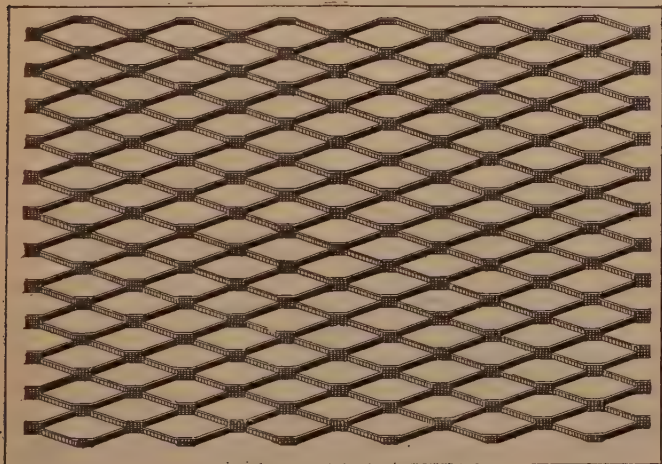
Then there is the sponge finish. The stucco is troweled or floated to a smooth surface and immediately finished with a coarse sponge, using the sponge in the same manner as a stippling brush. A fine or coarse sponge can be obtained as desired, dependent upon the pressure that is applied to the sponge. It is necessary that the sponge be moist, but not wet all the time that it is being used, and that it be kept clean and free from particles of stucco that may cling to it, by frequent rinsing.

Again, there is the float finish, which is produced in the same manner as floating and troweling that is practiced by plasterers, but it is recommended only in panel and half-timber work and where certain architectural effects are desired.

In the case of the stipple finish, the results are obtained in the same manner as the sponge finish, except that a brush having about a 6-inch fibre bristle is used. An ordinary coarse bristle new bar broom cut in half makes an excellent implement for this work.

METAL LATH AND ITS ROLE

So much for stucco. But how about its base—the thing to which it holds? We have learned that stucco clings pretty well to almost anything from bricks to hollow tile. In the case of a frame building, it is necessary to prepare some base for the stucco, and this



Typical metal lath. This material comes in sheets and may be readily applied on the studding of a new house or over the siding of an old house.—(Courtesy Sykes Metal Lath & Roofing Co.)

generally comes down to a matter of metal lath or wood lath.

Metal lath comes in sheets and may be readily applied on the studding of a new house or over the siding of an old house that is being remodelled. Perhaps no metal lath requirement is as severe as that for stucco. Cement and sand are heavy—the base and reinforcement for such a coating must be strong. Stucco must endure weather conditions, heat, cold and dampness—and should be well built. If the base for the stucco

is not right, the stucco cannot be satisfactory. It is generally agreed, in this connection, that metal lath is an excellent base for stucco.

Because of the weight involved, if metal lath and stucco are to be applied to a frame building, the corners of each wall should be braced diagonally with 1 by 6 inch boards let into the studs on their inner side, and securely nailed to them. In back-plastered construction in which sheathing is omitted, at least once midway in each story height, the studs should be braced horizontally with 2 by 3 inch bridging set 1 inch back of the face of the studs. This assumes that the studs are 2 by 4 inches. Larger sizes would require correspondingly larger bridging. In sheathed construction no bridging is necessary.

In back-plastered construction, the metal lath should be fastened direct to the studding and back plastered. No sheathing is used. In sheathed construction, however, the sheathing boards should not be less than 6 inches nor more than 8 inches wide, dressed on one or both sides to a uniform thickness of $13/16$ inch. They should be laid horizontally across the wall studs and fastened with not less than two 8-penny nails at each stud. In back plastered construction no waterproof paper is necessary. In sheathed construction, on the other hand, a substantial paper should be laid in horizontal layers over the sheathing boards, beginning at the bottom, said paper being well impregnated with tar or asphalt. The bottom strip should lay over the baseboard at the bottom of the wall, and each strip should lap the one below at least two inches. The paper should lap the flashings at all openings.

Saving the old home, with its massive framework and substantial construction, by "overcoating" it with lath and cement plaster is common practice. The possibilities are remarkable. The skill of the designer often finds expression best in salvaging old buildings

by means of an overcoating of stucco. If the framework is sound a small investment in metal lath and stucco will bring big returns, and further upkeep and repair expenses will be eliminated. There are two methods of overcoating with metal lath: one is to remove the old siding when it is loose and shaky and



Applying Bishopric sheathing board to frame structure. Over this sheathing board may be placed metal lath or Bishopric stucco base, for holding the stucco.—(Courtesy Bishopric Mfg. Co.)

apply metal lath to the studs. The second method is to place the lath over the siding and plaster it. The

latter method should not be followed unless siding is solidly in place.

Aside from the usual metal lath, there is a plastering base consisting of a heavy felt saturated in clear tar and reinforced with No. 14 galvanized wires through and across the face of the felt in a three-inch by four-inch mesh. These wires when imbedded in plaster and backed up by the heavy felt form a reinforced concrete slab, rust-proof, water-proof, weather-proof, fire-retardant, sound deadening. Low in first cost, it saves in the plastering process, whether outside or inside.

It will be noted that the heavy galvanized wires woven through and across the face of the thick tar-saturated felt are not, in any way, attached to the felt. So, when the trowel presses the plaster against the fabric, that pressure forces the felt away from the wires, which are, in turn, completely embedded in the plaster. The felt backing, however, insures the use of only sufficient plaster to accomplish reinforcement, saving from 40 to 60 per cent of the amount of plaster which usually goes to form the key on any open mesh lath or is loss in dropping. The bond between felt and plaster is said to be perfect. When plaster sets, the reinforcing wires are completely embedded and protected from moisture which makes metal not so protected subject to rust and disintegration. The felt further protects the plaster from moisture, lending strength to the plastered slab.

On exterior work this fabric serves a double purpose. It is both lath and building paper, making it possible to lath and paper in one operation.

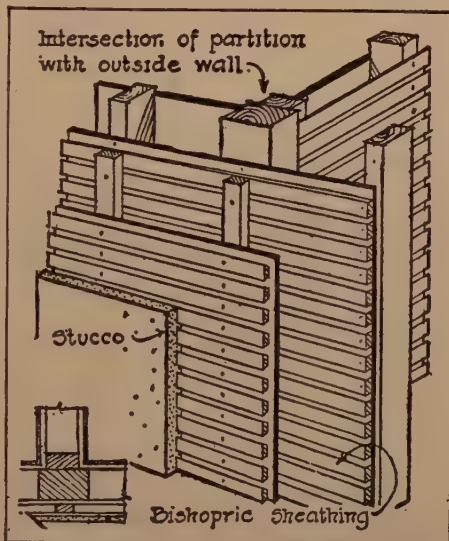
WOOD LATH STUCCO BASE

Aside from the metal lath base for stucco there are certain wood lath stucco bases, such as Bishopric and Byrnett products, which are a combination of units.

In the case of Bishopric, the background consists of heavy, tough, water-proof, durable fibreboard. By a special process this fibre board is given a heavy coat of asphalt mastic, whereby it is made tough, non-porous, pliable, proof against moisture, heat, cold, wind, air or sound; vermin and fire-resisting, so it is claimed. Into

this thick layer of adhesive asphalt mastic, carefully selected wood strips are imbedded under great pressure. These combined units produce a base of great strength and rigidity.

Bishopric is designed to hold stucco and plaster walls. The dove-tailed interlocking wood strips lock stucco and plaster in an inverted wedge clasp with a grip that holds



A warm and snug type of wall, making use of Bishopric sheathing, Bishopric stucco base, stucco, and Bishopric plaster base.—
(Courtesy Bishopric Mfg. Co.)

against time. When the stucco and plaster are applied, material and Bishopric weld, so to speak, into a single unit of strength and solidity. The weight of the average stucco wall, which is about 15 pounds per square surface foot, cannot tear off this wood lath base, because it can be nailed either to the

studding or sheathing much more securely than most other backgrounds for stucco.

The wooden strips, with their interlocking, dove-tailed keys, support the stucco between the studs, greatly reducing the strain of the weight of the stucco, and its consequent liability to check and crack. But more important than this, even, is the claim that this support will last as long as the building itself without deterioration.

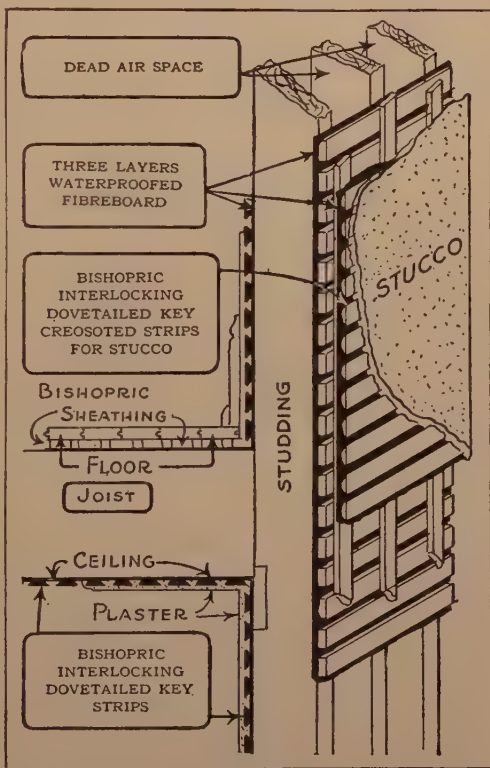
Bishopric, it is claimed, saves 25 per cent or more on stucco and plaster materials, because: first, the dove-tail key construction requires less stucco or plaster; second, the heavy fibreboard backing prevents stucco or plaster from going through and dropping down the spacing between the inner and outer walls. This base is claimed to be such a good non-conductor of heat and cold, that a material saving in fuel is effected. Building paper is not required, since this base furnishes its own insulation.

The asphalt mastic and fibreboard are sufficiently elastic to take up all expansion, according to claims. The stucco coating will expand about one-half inch to each 50 feet and an increase or decrease of one ten-thousandth of an inch in thickness of the backing will account for this amount of expansion. Thus the asphalt mastic backing, being elastic, will take up this expansion easily.

As the asphalt mastic will prevent dampness reaching the frame, no dampness can get at the wood strips from inside, and if the stucco is water-proofed, as provided in the stucco specifications in such construction, no dampness can strike it from without; moreover, the wood strips, being imbedded between the asphalt mastic and the cement, completely shut away from the air, there can be no air or moisture action and consequently no expansion or shrinkage. Further, if there were any actual expansion, as well as a theoretical

one, it could not be greater than any possible movement of the cement mixture in its chemical action in setting; therefore, any possible expansion or contraction would be so infinitesimal as to be practically nil. As a further protection against any possible air or moisture action upon the wood strips, the Bishopric stucco base may be obtained with wood strips creosoted.

This base has a fire-resisting backing in its thick coating of asphalt mastic, and the wood strips themselves cannot burn because they are imbedded between and in asphalt mastic element. If fire comes, the chances are it will start in the interior of the building, in which case a solid wall of asphalt mastic checks its travel.



Detail of typical use of Bishopric material, showing Bishopric sheathing, stucco base, studding, and plaster base.

With all the advantages of Bishopric base, one of its main points is its low cost. It makes for low building costs.

HOLLOW TILES AND THE HOLLOW-TILE HOUSE

So much for various metal and wooden supports for stucco. Now we come to the hollow-tile house, which lays first claim to stucco finish. Nevertheless, the builder of a hollow-tile house is by no means confined to a stucco finish, popular opinion to the contrary notwithstanding. There are other attractive ways of dressing the hollow-tile house.

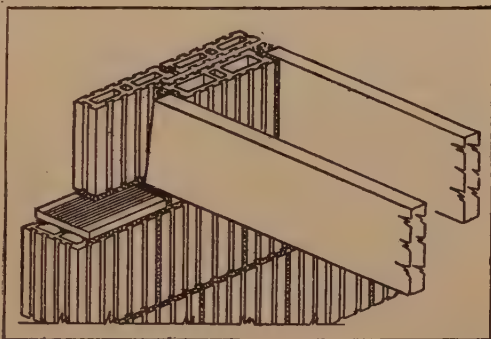
The main advantages of hollow-tile construction are permanence, fire-proof qualities, insulation from heat and cold, strength, and low upkeep. As compared with the usual solid brick wall, hollow tile has the added charm of excellent insulation, due to its dead-air cells. A house built with proper hollow tile may be heated to 70 deg. Fahrenheit in zero weather with 10 per cent less coal than the same house of different material, according to heating engineers.

In the chapter on materials we read about hollow tiles, and it is well at this point to go back to that section to learn about hollow tile as a building material. Suffice it to say here that hollow tile is not only confined to the construction of outside walls for small and large houses, but it is also largely employed in the construction of factories, office buildings, schools, and other large structures, both for exterior walls and for fireproof partitions. Manufactured in larger units than brick, no other building material embodies possibilities for so wide a variety of surface treatments as hollow tile.

Hollow tile is manufactured in several styles. Thus there is a large unit which comes in various thicknesses laying up one square foot of wall surface and heavily

scored all around to hold mortar, interior plaster and an exterior finish of Portland cement stucco applied directly to the surface of the tile. Another typical hollow-tile is a slightly smaller and more flexible unit, manufactured with a 5 by 12 inch rough texture face, in mixed shades of brown and red, and is well glazed all around. It is safe to say that no building material makes a more desirable structure, embodying as it does

real possibilities for so wide a range of surface treatment, dark reds and browns of this tile being combined with white, black, or cream-colored mortar joints and all the shades and finishes



Detail of a good method of seating joists in thin tile walls.—(Courtesy Bureau of Standards.)

of cement stucco if the tile are to be covered over. Several buildings erected from the same plan can be made to look like a variety of designs by giving them different combinations of exterior surface treatment.

The usual hollow tile is not finished on the outer surface, but bears on four sides a surface deeply dove-tail scored to receive a plaster treatment, both inside and out. A Portland cement plaster or stucco in any one of the various finishes known as "sand finish," "stippled sand finish," "rough cast," and "pebble dash," is applied to the exterior wall surface, and ordinary plaster directly to the inside of the tile walls without lathing or furring of any kind, if desired. However,



Hollow-tile house under construction, as well as a masonry chimney.—(Photo. by the author.)

it is well to bear in mind that this is a highly controversial question. Some builders do not believe in plastering directing on the hollow tile wall for interior finish, but prefer to do the usual lathing and furring so as to provide an additional air space between the

plaster and the hollow tile. If the inside is to be furred, it becomes necessary to make holes in the hollow tile to fasten furring strips in place, which in turn hold the wood lath or metal lath which receives the inside plaster. This is a rather tedious and expensive job.

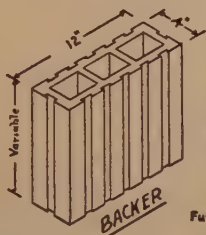
Perhaps no exterior finish, except the textured surface tile, makes so beautiful a home as pebble dash. Next to this comes rough cast, then stippled sand finish. It is characteristic of these finishes that they mellow with age, the shadows taking on a deeper tone while the high lights remain about the same. No other finish, perhaps, blends so perfectly with the background; no other finish presents such a soft tone free from disquieting "patterns." No other treatment has been so long in use except perhaps brick and stone. Some of the most artistic buildings in Europe owe much of their beauty to the judicious use of stucco finish.

A surface treatment for hollow tile, adopted universally and with good effect on all kinds and sizes of

HOLLOW TILE BACKING FOR 8" & 10" WALLS

DETAILS SHOWING FLEMISH BOND

8" WALL



NOTE

BACKER TILE ARE USUALLY CUT TO A HEIGHT OF $10\frac{1}{2}$ " TO COURSE WITH BRICK OF STANDARD $2\frac{1}{4}$ " THICKNESS AND $\frac{1}{2}$ " BED JOINTS

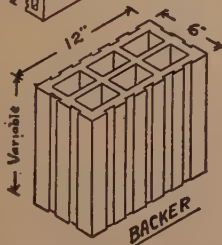


HORIZONTAL SECTION - COURSE "A"



HORIZONTAL SECTION - COURSE "B"

10" WALL



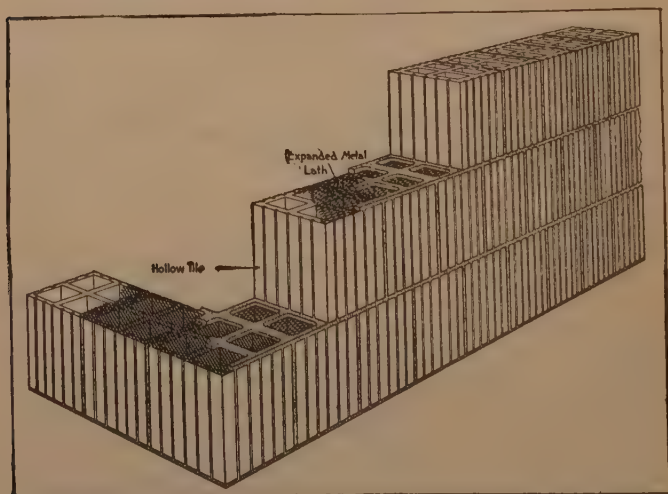
HORIZONTAL SECTION - COURSE "C"



HORIZONTAL SECTION - COURSE "D"

Interesting use of hollow tile backing for 8 and 10-inch brick walls. This construction produces a brick veneer effect, although in this case hollow tile is being employed instead of frame. Hollow-tile backing, with its dead-air space, provides excellent insulation to heat and cold.—(Courtesy Bureau of Standards.)

buildings, is the facing of exterior walls with one course of brickwork. This treatment must not be confused with solid brick wall construction. It is simply a veneer of bricks backed up by hollow tile, thereby eliminating all the drawbacks of a solid brick wall. In this form of construction it is the heavily scored hollow tile which gives strength, rigidity and solidity to the structure and keeps the house warm in winter,



Careful hollow-tile wall construction, reinforced at joints with expanded metal lath for saving plaster and tying the wall together.—(Courtesy General Fireproofing Co.)

cool in summer, and dry at all times. The floors and roof are carried by the hollow tile and even the brick veneer is tied to the tile wall for support, with galvanized iron anchors spaced 2 feet apart at every fifth course of brick.

Walls laid up in this manner cost more than either

textured surface tile walls or walls of hollow tile surfaced with stucco, but will prove entirely satisfactory to those who prefer a brick finish without the disadvantages of a solid brick wall and who are willing to pay the difference in cost. A hollow tile wall, faced with brick, is far better construction in every way than solid brick walls and usually costs less. Again, some very pleasing effects can be had on any building designed to be stuccoed by working in quoins, sills, lintels, watertables and other details of textured surface tile or brickwork. Such details are necessary parts of the building, which in a stucco finish are treated the same as the rest of the wall surface. The use of textured surface tile or brickwork, however, effects an harmonious contrast of great architectural beauty and can be recommended as one which gives pleasing variety to the already large number of surface treatments for hollow tile.

As far as construction methods are concerned, there is little to be said about hollow tile. The process is more or less self-evident. The masons lay the tile in much the same manner as brick, except that the units are larger and the work progresses at a faster pace. However, care should be taken to make sure that the work is properly done. It is well to use metal lath, if possible, as shown in the sketch on page 220. Failing in this, some builders use heavy wrapping paper over the air cells, so as not to let mortar drop into the hollows. The wrapping paper is broken after the wall has proceeded to a higher level. If mortar is dropped into the air cells, the insulating properties of hollow-tile wall are materially reduced.

Another point to watch out for in hollow-tile construction is the proper finishing of the odd corners and the work about the windows and doors. The straight wall is a simple enough matter, but when it comes to joining up the wall with the sloping roof, with

door and window openings, and so on, considerable skill and care are called for. Otherwise, a leaky and unsatisfactory house must be the result.

The plainness of stucco walls may be broken up in a variety of ways. The ingenious mason will find ways and means of inserting an attractive row of bricks here and there, as well as insert a colorful bit of tile here and there, always with the purpose of adding a touch of color to the otherwise monotonous wall. This is a matter which should receive some attention from the home builder, for very little additional expense is involved despite the greatly enhanced appearance of the finished house.

Also, in the case of a stucco house it is well to have the roof harmonize with the stucco walls. If composition shingles are used, the various shades of green and red should be carefully studied with a view to selecting the best shade of either the red or the green with respect to the stucco finish of the building.

CHAPTER IX.

THE HOUSE BUILT OF STONE AND ARCHITECT FLAGG'S IDEAS

THE stone house is a matter of location. With brick, hollow tile, frame and concrete, we can build anywhere we please, but when it comes to stone construction it is a matter of location. Of course, if money is no object, then the stone house can be constructed anywhere and at any time; but if cost is the primary consideration, which it generally is with the house builder, then the stone house is confined to localities where good building stone is readily available.

The stone building dates back to the beginning of history, and nothing is more conclusive proof of the lasting properties of masonry construction than the ancient buildings which have come down to us, more or less intact. In our own country we have ample evidence of the durability of masonry in some of our Colonial dwellings. In northern New Jersey, particularly, we have numerous stone houses built by the early Dutch settlers, which stand today just as they did when they were constructed. These houses are often bought and remodelled and improved, giving the owner a more substantial dwelling than he could possibly erect today for anywhere near the money involved. The writer knows of a masonry stable, erected on the

upper end of Manhattan Island, New York City, back in 1853. Several years ago this masonry stable, constructed of large, smooth, uniform-sized square gray stone, was bought by a publisher of unusual vision or imagination, whichever you please to call it. The stable was cleaned out. The archway was closed in and became the large entrance and hall of the dwelling. Additional windows were cut in the walls, which measured about two feet thick. The roof was relaid, the trim was painted, the inside was remodelled, and the stable of 1853 became a large and attractive house of today. This dwelling, needless to say, will last for a dozen centuries or more, if allowed to run its normal course. Little wonder, therefore, that conservative and economical Europe builds largely of stone, so that a house may be handed down from generation to generation almost without end.

GOOD STONE AND WHERE IT COMES FROM

The stone house is most adaptable in regions where good stone is available. If local stone is not available, the transportation charges run so high that the builder might as well use brick or hollow tile, except if stone is desired at all costs. Often the stone is available from the excavation of the cellar, if the house is being constructed on rocky terrain. Again, in certain parts of the country there are to be found loose stone walls surrounding land holdings. At the time the early settlers cleared the ground, they piled up the loose stones in the form of walls about their plots for the two-fold purpose of getting rid of them and making a permanent fence. If a loose stone wall is available on the property, the problem of building a stone house is materially simplified. Of course, it does require a considerable extent of loose stone wall to put up a two-story stone wall for a house, or even a single-story

wall. Still, if there is insufficient stone, an additional supply may be bought locally to finish the wall. In the writer's home town on the Hudson River, stone is abundant and there are numerous stone houses. If the stone is available on the building site and does not have to be bought, masons are ready to erect stone walls at 45 cents per cubic foot of wall. If the stone has to be supplied by the masons, then the price runs up to 60 cents per cubic foot of wall. At these prices stone construction is not very much more than frame, but it remains less expensive than brick and perhaps the same price or a trifle less than hollow tile.

Although stone is not as flexible as frame from an artistic point of view, much may be done with the stone house if the stone selected is of attractive texture and color, and if it is properly laid. From a mechanical standpoint, the wall should be properly bonded together. The lintels over the windows and any arches that may be involved in the construction should be strong and, if necessary, properly reinforced with wood or steel. This feature may be left to the architect or the skilled contractor. The foundation of the stone house should be unusually substantial, for stone walls are heavy.

Of the various native stones available, there are those which split into long, flat shapes, others which break into irregular chunks, and others which are sufficiently soft to permit of trimming into square blocks of uniform size. Even small boulders—smooth, round stones—may be employed in the stone house by imbedding them in the face of the wall so as to produce a surface of round bumps. Architectural authorities point out that native stone should be used as it is found, and under no circumstances should it be fussed up and made to look like something else. Thus it is a waste of time and money to trim hard stone—which comes in irregular pieces—into uniform sized, smooth blocks in

order to construct a formal type of dwelling. Aside from the expense, the result is bound to look forced, artificial, and highly inartistic. So, in brief, the native stone should be used as it is found, or as close to its natural state as possible.

BUILDING THE STONE WALL

Building the stone wall is a job for the mason. The simplest and commonest stone wall is that in which the stones are of irregular shapes and sizes, and are simply fitted into place without regard to even courses. The mason, as he works, picks out one stone after another and fits them together with remarkable precision, thus allowing for a minimum of mortar to fill the joints. There are large stones and small stones, the latter being called "spalls" and serve as fillers, so to speak.

The joints of mortar between the stones may be finished in various ways, always in keeping with the general architectural effect desired. Thus these joints may be roughly plastered over, covering much of the surface of the stones themselves. Again, the joints may be neatly filled up flush with the surface of the stones, thus showing a pattern of the fitting together of the individual stones. The joints may be recessed and even tooled so as to produce a uniform V-shaped trough or even an inverted V-shaped ridge. The finishing of the joints is known as "pointing" the walls, and is of prime importance in making for the utmost attractiveness. Even more than the selection of attractive stone, it plays an important part in the architectural result.

Stone may either be laid as it is found, without trimming of any kind, especially when it is hard stone, depending on small stones or spalls to fill the gaps, or it may be trimmed roughly so as to make up the

wall of large stones throughout. The latter practice results in what is called the "cobweb rubble."

The mortar used for the stone wall is of the utmost importance. Foundation walls which are subject to dampness should be built with Portland cement mortar. For walls above grade, however, lime mortar may be used. Still, cement mortar or cement-lime mortar is superior, since it stands weathering to the greatest extent. The mortar should be used unsparingly but wisely, for it is the very backbone of the structure.

The stone wall should be a single, solid structure. It should not consist of an outside and an inside face. In order to make sure that the entire structure is thoroughly joined together, the best practice calls for what is known as a bond stone, which is laid transverse to the wall or passing from one face to the other. Bond stones should be laid in the wall for every two feet of height and every three feet of length. The bond stones should be flat and measure 12 inches in width by 8 inches in thickness.

As for the dimensions of a stone wall, it is best to make it good and thick. It costs very little more to make the wall thick while one is building, and the extra sense of security in the finished structure pays dividends in the long run. The usual thickness for the walls of a three-story building is 16 inches, while the foundation walls for such a structure run 8 inches thicker, or 24 inches. The footings should be of concrete, at least 12 inches thick and extend about 5 inches beyond the walls on each side.

MAKING THE STONE HOUSE DAMP-PROOF

To the layman the stone house, like the solid brick house, is looked upon as being absolutely impervious to all conditions of weather. Such may be the case, but nevertheless, strange as it may seem, the stone house,

as well as the solid brick house, is often damp, unless certain precautions are taken. The masonry walls by themselves are not sufficient protection. Not only will the interior surface of such walls show condensation of moisture as the result of temperature changes, known as "sweating," but dampness comes through the wall joints. Hence it becomes impossible to plaster directly on the stone walls, much as we should like to do so in order to save money in construction.

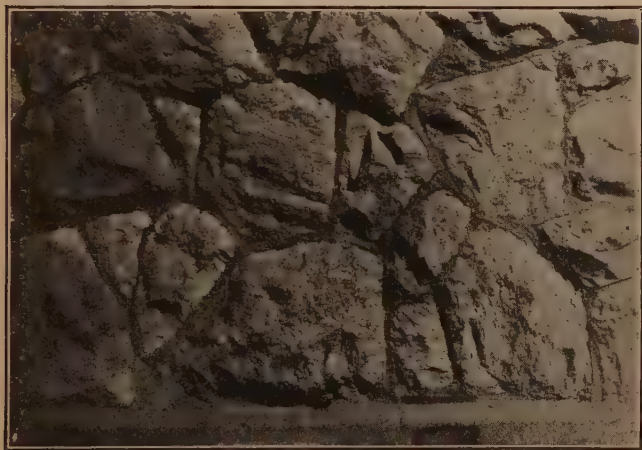
The stone house, like the solid brick wall—the Ideal brick wall, described elsewhere, is free from this fault—must be furred inside before the lath and plaster can be applied. The furring is accomplished by lining the inside stone wall with 1 by 2 inch wooden strip, held to the stone wall by driving nails into the mortar joints, or, what is still more positive, holding the furring strips in place by means of expansion bolts let into holes in the mortar. Patented furring strips of metal are also employed. Occasionally, hollow-tile furring blocks are employed. At any rate, the furring strips are mounted on the inside stone wall, so as to afford a base on which to support the lath or plaster boards. In this manner an air space is provided between the final inside wall, whether it is plaster, plaster board, sheet rock, or what not, and the stone wall. Sometimes stone walls are built hollow by certain arrangement of the stone or by the incorporation of hollow tile. Such air space as is included in this manner permits of plastering the stone wall directly, if desired, although at all times it is preferable to retain the furring.

Because of the complications of furring as well as supporting the inside construction in the stone walls, builders who are not hampered by financial considerations go to work and construct what amounts to a house within a house. A frame is erected in practically the same manner as though a frame house

were being constructed. Then the masonry wall is built about this frame structure. Thus all the interior of the house is taken care of by the frame structure.

A CROSS BETWEEN POURED CONCRETE AND STONE

It has remained for the well-known architect, Ernest Flagg of New York, to develop a new idea in masonry construction, which not only makes for good mechan-



Simple form of stone wall, with plain tooled joints, roughly pointed.—(Photo. by the author.)

ical construction and attractive appearance, but also for low cost. Ernest Flagg is that resolute and implacable artist from whose drafting board sprang the first of the great towers which characterize Manhattan's famed skyline—the Singer Building. He is the designer of the Naval Academy at Annapolis and of many well-known architectural works such as the Corcoran Art Gallery at Washington. But the real interest of Ernest Flagg, just now, is not in the great

public building or the mansion in which cost is the element of least importance. It is in the house which costs its owner from three thousand to five thousand dollars. For the past twenty years he has been experimenting with ways for improving its design and the construction of its units. He is able to build houses for ten thousand dollars which, so it is claimed, would cost a full twenty thousand if produced by the usual conventional methods. He has been able to devise plans which, using ordinary methods of building, save a third of the cost, making possible the building of a house for six thousand dollars which, to provide the same cubic useful content, would cost nine thousand dollars or more if drawn conventionally.

Because the Flagg house is essentially a stone house, we deal with it in this chapter. However, it should be borne in mind that many of the features of the Flagg house apply equally well to other types of houses. Furthermore, the ideas advanced in what follows are those of Flagg the architect, and are not to be regarded as those of the author of this book. Flagg's ideas are quite unorthodox—doing away with the cellar, with the attic, with window frame and door casings, with trim, with elaborate fire-places and chimneys, and so on. The mere fact that the author has included the Flagg methods herewith, taken from an article which was published in the *Scientific American*, must not be considered as an endorsement of Flagg's methods. They are offered here as a matter of general interest, for the reader's stock of knowledge.

Flagg, like Ruskin, is a hater of sham. He believes that sham is always ugly. He goes straight back to first principles, as every inventor must, and examines the reasons for the existence of everything in which he is interested. If he likes he may boldly throw away a thing which we are accustomed to regard as an essential. He begins the design of his small houses by first

completely discarding both the cellar and the attic.

You can imagine this architect examining the various items in the expense of building. A cellar costs usually about 20 per cent of the total cost of a house. Why do we have cellars at all? Once, of course, they were used as refrigerators and contained great storage spaces for a winter's supply of vegetables. They were cool and damp. Then somehow the belief grew that a damp cellar kept a house dry. Yet dampness pervades the house just as surely as coal gas does after improperly stoking a furnace in the cellar. A cellar was supposed to keep a house warm, which it does not unless you have a furnace which most extravagantly heats the whole cellar. So long as you have a proper floor and a tight foundation a cellar is an extravagance, so claims Flag in the face of a great deal of opposition.

To take the place of a cellar this ingenious architect adds above ground storage space in which furnace and coal bin are housed at very much lower cost. Either hot water or steam heat can be as easily arranged on the ground floor as underneath the house, and he is experimenting and is using himself a warm air heater with a small fan in the incoming duct, which arrangement has proved satisfactory. The necessity of climbing up and down stairs to tend the furnace is done away with. The mass of the house is increased—always desirable from the standpoint of appearance. Beneath the floors, while the house is being built, concrete is laid on the ground and given a coat of waterproofing which extends clear across the foundation walls to make a coursing. This provides a watertight construction which also prevents molecular attraction in the stone walls from rising above the ground level. There is a small cubic area of dead air space between the concrete and the floors. Dryness and warmth is

much more certain than were you to try to build a cellar.

The attic in most houses is either useless space or expensive and inconvenient storage space. It costs from eight to ten per cent of the total cost of the house and on the whole is unjustifiable. It is supposed to keep a house warm in winter and cool in summer. As a matter of fact it is a large, roofed space which may absorb much of the heat generated within the house in the winter time. And it is valuable. In either one or two-story houses Flagg runs his rooms to the roof peak and provides a ventilator, which he has perfected, to keep the rooms cool in summer. These ventilators take one of two forms—an attractive ridge dormer, or a small, cheap skylight which opens and is screened. Because hot air rises, when these openings are free all the air within must be as cool as the air outside the house. The stifling hot attic is eliminated.

The ridge dormer, as its name clearly implies, is a square box-like opening on the roof peak at convenient points. It is usually kept open all summer but can be closed by means of a pull on a cord which swings the glass window shut. The ventilator, which is a cheaper substitute, is a hot-bed sash with copper flashing, a single strip of copper forming the hinge on one end and serving also to keep out water. People may be skeptical about such simple arrangements and the only answer to them is that they have been used for years in Mr. Flagg's own houses, and tenants have found them thoroughly satisfactory in every way.

MASONRY WALLS WITHOUT MASONS

Because the stone house is fireproof and permanent and cheapest to build in the long run, Flagg uses stone for walls exclusively. He has invented a way of laying rubble stone walls, which are quite beautiful, without

the help of stone masons. Also, he has cut the cost in the neighborhood of New York from 45 cents a cubic foot to 6 cents a cubic foot. This novel stone construction starts in the trench for the foundation wall, with dry stone. When a foot has been laid cement is shoveled in and from there on up to the ground line the wall is of ordinary masonry which can be laid by



A more elaborate form of stone wall, in which the joints have been carefully tooled to make them stand out.—(Photo by the author.)

a laborer in an open trench. At the ground line or a few inches above, it is finished off for the coursing of waterproofing compound. From here on the work is more like pouring concrete than masonry.

Forms are erected which consist of four by four uprights as high as the finished wall is to be. At the top an alinement truss holds them, and at intervals all the way down twisted wire spacers are used. Three 8-inch planks are slipped into position at the bottom. Workmen lay stone with the straight face out, each against

the board forming the box. Concrete is shoveled in behind these face stones. This section of wall, two feet high, is then left over night. In the morning the planks are lifted up to the height of the wall and secured with pins. Another section of wall is laid all around. Window frames are set by the foreman as the wall is built.

While it would not pay to build a set of four by fours and trusses for one very small house, it would pay for two or more because no matter what the size of the house the same forms are employed and they come to no harm in actual use. The wall when completed must be pointed on both sides, an operation which is performed by holding the mortar board at right angles and pushing the mortar into the spaces between stones. It may be of advantage to use a mason for this one brief job. Flagg's walls are, of course, very low because he utilizes all the space under the roof and because the house is not lifted on a high foundation. His practice is usually a five-foot wall for one story and a twelve-foot wall for two stories. Thus he readily achieves the effect of the low dwelling, sturdy and well anchored, that modern architects so often unsuccessfully attempt.

The most amazing invention which this inventive architect has made is of a new kind of partition. The ordinary one is generally about six inches thick and is a series of flues for fire. It is expensive from start to finish. In space wasted, alone, a partition can be figured to cost \$3 a running foot, minimum. Flagg partitions are only about an inch and a half thick, yet they are as sound-proof or more so and plenty strong enough.

Along the beam where the partition is to go Flagg hangs widths of jute scrim from screweyes. These are basted together to form a curtain. Two plasterers, facing each other, work against each other's boards and

put on a first coat. This curtain then hangs plumb and is slipped into a special baseboard to fit. Then the next two coats of plaster are put on in the usual way. The resulting thin partition has been given every possible test in use and in the laboratory. The New York Building Department, which formulates the city code, tested this partition before permitting its use some 10 or 15 years ago in a New York tenement house of model design. In this test cord wood to a height of two feet was soaked in kerosene and ignited in a closed room of the test building, the walls of which were formed in the way described. After the interior had been burning long enough to have consumed ordinary partitions, a fire hose was turned on the hot walls from outside at high pressure and no damage was done to them except for the development of a slight bulge and a tiny crack. They were okayed for use. The writer, being skeptical about the strength of such partition construction, pounded one of these walls with his fist as hard as he could and was unable even to vibrate it. Their economy is obviously self-evident.

A NEW IDEA IN ROOFING

Roofing is one of those things in which we have made some improvements in the past century, but even in these Flagg has devised a method for using them which is better looking and cheaper to install. He first cuts 36-inch, roll roofing into strips nine inches wide. The second strip of roofing is nailed on with only a two-inch overlap, a metal clip being placed under each nail. Each nail is covered by the succeeding strip of material, only the clip, which is bent over the edge of the next piece to keep it tight to the roof, is exposed to the weather. The nails are put in so that the clips form a straight line at right angles to the edge of the strips of roofing. The finished roof weathers, forming a thin

streak in line with the clips. In a year the roof is divided into perfect squares and is actually beautiful. In 15 years of service, using the cheapest sort of material, no leaks have developed, according to report. The edges of the roof are faced with a copper or lead band, nailed on.

Again our inventive architect finds that rain gutters and leaders are ugly to the eye and in most places quite unnecessary. He simply leaves them off the houses he builds. Around the walls he puts a narrow concrete walk which carries off the water as it falls from the eaves. Only above a terrace or in a similar place does he permit gutters. He trenchantly says: "The design of many a house has been ruined by numbers of great ugly tin pipes running down the walls or down pillars which otherwise would be beautiful in every line."

There is room to describe here but a few more of his economies. He says himself that he has been able to effect them in every part of the building except in electric light wiring. He tackles plumbing, screens, ceilings, beams, casement windows and so on. In each case old conventions drop by the wayside and his simple, rugged houses result. One or two details among these are so interesting that they should be mentioned. Take the case of the fireplace. Most of them simply cannot be expected to give out any heat. They are expensive. A Flagg fireplace, on the other hand, not only heats a room very well, but also costs but little. For twenty-five or thirty dollars he builds what would cost from two hundred to five hundred, ordinarily.

AN OUT-OF-THE-ORDINARY CHIMNEY AND FIRE-PLACE

A chimney rides on the roof peak of the gable, practically a part of the stone gable itself. A slight indentation in the thin building wall—six inches at most—is lined with fire tile. There is no chimney of stone

and mortar below the roof. A hood of the size required is hung out from the wall at the proper height. From this hood to the chimney in the roof extends a bronze or copper half-cornucopia. The fire is thus open on three sides. The bronze or copper chimney is a remarkable motif for the decoration of the room. Most important it is a great hot box which heats the room the way a stove does. In a large house which is now being finished the bronze sheeting and hangers for the hood cost in New York just \$12.50. This odd chimney was cut out of a single sheet so as to make three pieces, which were then riveted together.

The problem of the stairway is one upon which this architect has put a great deal of thought. It is one of the most expensive built-in pieces of furniture which we use. The stairway in a great many millions of American houses is not only expensive and wasteful of space in itself, but is also a creator of waste by requiring long upstairs halls. It is usually thoroughly ugly. In Europe for centuries a practice often used has been to have vertical communication instead of longitudinal. Halls are thus eliminated. Now that even our small houses are built with two baths or more, one of them for the use of the servant, we could adopt this principle if stairways were not so costly.

Into a concrete form Flagg pours cement and forms a step. With a series of these he builds a circular stairway at very low cost. It is so designed that it is easy to use; and in his houses, since the walls are low, the height of these stairways is not forbidding. The space they occupy is indeed very small. In building them, the steps are stacked upon each other and then cemented together. They are so cheap that you can have one wherever you would find it convenient in the house. You will be amazed at how two or three of them at most in a small house will cut costs and simplify

your general design. Moreover they are amusing and unusual—fireproof, of course.

The Flagg system of home construction is well worth considering, in whole or in part, especially in these days of abnormal building costs. Fortunately, architect Flagg has written a book entitled "Small Houses," published in 1922 by Charles Scribner's Sons of New York. This book not only gives the views and ideas of this progressive architect, but it also offers numerous plans for Flagg type houses ranging from the modest cottage to the mansion.

Small houses following the unique ideas described have been built and have proved quite satisfactory in actual use.

CHAPTER X.

THE HOUSE BUILT OF CONCRETE

THE concrete house offers many possibilities which have, as yet, not been fully realized by American home builders. Indeed, it seems safe to predict that the concrete type of dwelling will become increasingly popular in the next few years, thanks largely to the efforts of the cement manufacturers to instruct architects and home builders in the possibilities of concrete construction, not to overlook the many excellent designs for attractive dwellings which have been worked out by the cement manufacturers and their association.

THE VERSATILITY OF CONCRETE CONSTRUCTION

To the laity the mention of concrete as a building material often means an ugly dwelling of crude concrete blocks, such as is so much in evidence in sections inhabited by Italian laborers, who are unusually partial to masonry construction. As a matter of fact, the use of concrete is by no means confined to concrete blocks, and even if concrete blocks should be used, there is no reason why they cannot have an attractive surface finish and, better still, why they cannot be given a finishing coat of stucco in a manner quite similar to the hollow-tile house or the stuccoed frame house.

Concrete construction can take the form of monolithic concrete—concrete poured so as to form a solid structure. Years ago the inventive mind of Edison

foresaw the possibilities of concrete in the construction of inexpensive dwellings, and he worked out an economical method of erecting standard moulds and pouring concrete into them to form the walls of houses. Much may yet be done along this line, but for the time being the poured type of concrete dwelling is quite rare.

Then there is the plastered or concrete gun type, in which the concrete wall is built up by plastering or shooting concrete on expanded metal or mesh reinforcement, so as to form comparatively thin double exterior walls—virtually a stucco house.

Concrete blocks and concrete tiles lend themselves admirably to dwelling construction. Because concrete blocks and concrete tiles may be manufactured locally with cement and domestic sand, the cost of this building material runs quite low. Yet the finished structure has many advantages which speak well for this type of dwelling.

THE MONOLITHIC CONCRETE HOUSE

The appearance of a house, while a secondary consideration from the purely utilitarian standpoint, must not violate the principles of architecture, proportion and harmony with surroundings. A monolithic house may be built after any architectural design and be of any form or size, but to keep cost down, forms must be susceptible of repeated use. But standardization does not mean monotony if the problem is handled with proper skill. If a general style and plan are produced which are architecturally correct, variety can readily be introduced in details and location of entrances, execution of porch and roof details, surface treatment and facing direction of front elevation. Irregularity of design, bay windows, curved surfaces or oblique angles, are not necessary to give pleasing appearance to a large group of houses.



Reinforced concrete house with the wall finish not yet bleached out. This type of construction provides a substantial construction at a moderate cost, while the upkeep is reduced to a minimum.—(Photo. by Scientific American.)

Concrete is a distinct material and must be studied in order to produce artistic effects economically. It offers a splendid opportunity to the architect to display his skill.

Experience has demonstrated that elaborate systems of elevating and spouting concrete are not economical for house construction. Relatively small mixers and simple, easily moved hoisting apparatus, such as a single mast or two-legged tower carrying a small skip, wheelbarrow runways or light conveyors, have proved best suited to concrete construction.

The thickness of walls of monolithic houses is governed by considerations of field practice rather than by the requirements of strength, since any thickness of a well constructed concrete wall that can be economically built with forms will be amply strong. Well built 6-inch concrete walls require little reinforcement for structural reasons and do not need more than $\frac{1}{4}$ of one per cent to provide for temperature stresses. A suitable concrete mixture for such walls is a 1:2 $\frac{1}{2}$:4 with maximum size of aggregate about one inch. Broken stone, pebbles or a good grade of slab may be used as coarse aggregate. —

In latitudes where changes of temperature may be sudden or involve a wide range, a dead air space throughout exterior walls must be included or an air space must be formed by furring and plastering or by using some other insulating medium between a solid wall and the interior finish as in the cases of the solid brick and the stone houses.

Complete fire-safeness requires concrete floors, partitions and an incombustible roof. Concrete floors should preferably be covered with rugs, carpets, linoleum or special floor coverings that may easily be removed. However, in the usual concrete house the practice is to finish the inside with the usual frame construction,

despite the fact that such practice is not in keeping with absolute fire-proof ideals.

Stucco has been found a satisfactory finish for the exterior surfaces of a poured concrete house. Attractive finishes have also been obtained by exposing colored aggregates, by tooling the concrete surface, by sand blasting and by rubbing. Troweled finishes are not recommended.

Window and door frames can be set in the forms and the concrete cast around them. Wooden frames should be well primed as a protection against absorption of moisture from the fresh concrete placed against them, and should be anchored to the concrete by long spikes or bolts.

THE UNIT BUILT CONCRETE HOUSE

Concrete houses in which wall and floor slabs, beams, girders, partitions and columns are precast at some convenient central point, conveyed to the building site and there assembled to form the finished structure, are called unit built. At the time of casting, all surfaces which are to be exposed to view in the completed structure are finished with a wood float, with pebble dash, exposed aggregate, or any other finish desired. Any surface which is to be stuccoed after erection should be scored at the time of casting the unit to provide a suitable ground for the stucco.

In quantity production of houses a type of architecture should be selected which will meet the actual requirements of a definite housing project and permit of sufficient standardization for maximum economy and minimum time in erection. The single house must be subordinated to the group idea and the work must be done in conjunction with the town planner and engineer in order to produce a practical development, both from the aesthetic and financial standpoints.

Unit construction is suitable for any form of architecture which permits a reasonable duplication of standard structural members. Houses intended for the so-called skilled artisans or workmen whether to be rented or sold to such intending occupants, should be of a detached or semi-detached type. Houses intended for the lower social classes of workmen such as the foreign element and which are to be operated on a rental basis, should be built in groups, having fire walls between individual quarters. In congested districts the apartment structure with quarters of two, three or four rooms and bath, is the most suitable.

From a recent national conference on concrete house construction, the findings of which have formed the basis of the bulk of this chapter, it is learned that 281 unit-constructed houses were built by a metal products company in Youngstown, Ohio, several years ago for the housing of its employees. These houses consisted entirely of reinforced concrete members for the walls, floors, partitions, and second story ceiling. The roofs were framed in timber and covered with tile. This extensive use of reinforced concrete members eliminated about 75 per cent of the carpenter labor and 80 per cent of the plastering required under ordinary methods of construction. Revised designs and engineering plans prepared by the company which supplied the units contemplate the use of steel sash, mastic floors, complete elimination of wood trim, the adoption of concrete baseboards and concrete roofs, thereby dispensing with practically all carpenter work on future operations.

In another type of unit construction, 90 per cent of the building is made in moulds and afterwards assembled on the foundation wall. The remainder of the structure consists of studs, tie beams over partition studs and stair stringers, cast in one place. The walls of the buildings are composed of thin panels set up and

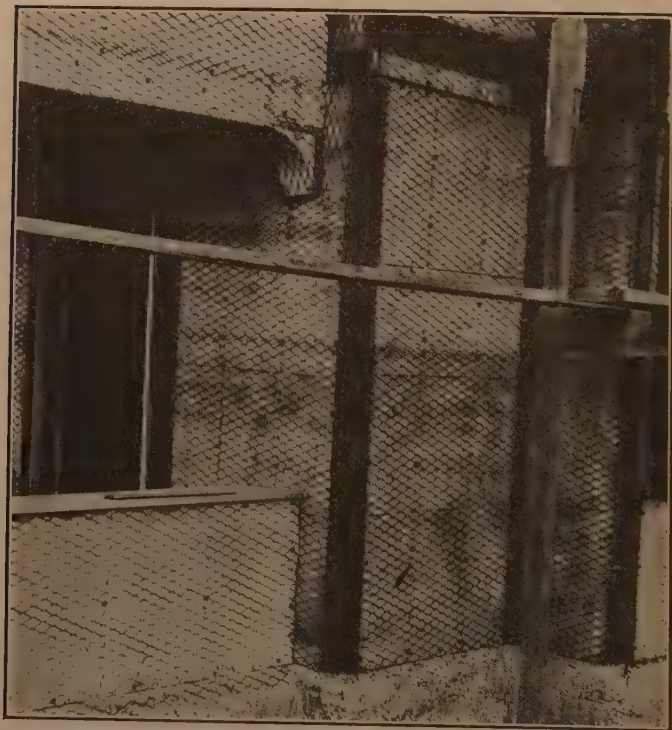
held in place by channel-shaped concrete stud forms. Floor beams are "T"-shaped and are set up so that ends rest on and are bound to the field cast studs. After the walls and floors are erected, heavy waterproof paper is forced over galvanized iron hairpins embedded in the studs, and metal lath placed with the rib toward the paper, and the ends of the pin clinched over the rib of the lath, thus providing a second air space between paper and plaster. This construction has been used in this country as well as in Canada, and also at various places in the devastated regions of France and Belgium.

Concrete units made after what is known as the Moore system of construction consist of standard channel-shaped, vertical wall sections, roughly 8 by 12 inches, running the full height of one story with the open side of the channel turned in. The sections are reinforced and are deeply scored on the outer face to form a ground for stucco finish. Each section is moulded jaw shaped at the top. When a row of sections is set in place, these jaws form a continuous open channel which is then filled with reinforcing steel and concrete. By this method a continuous monolithic girder is formed at the top of the wall and the sections are definitely tied together. Application of building paper, lath and plaster to the inside of the line of channels produces a dead air space for insulation. The wall sections are set in a mortar base and are supported on concrete foundation walls or directly on spread footings.

PLASTERED AND CONCRETE GUN TYPES OF CONCRETE HOUSES

The plastered or gunite concrete house is one having a protected metal or a reinforced concrete structural frame, the latter being either cast in place or shot with

a cement gun and having comparatively thin double exterior walls of concrete, formed by plastering or shooting concrete on expanded metal or mesh rein-



Wire mesh in place, ready to receive the cement from the cement gun. This method saves much time and labor, and therefore reduces costs.—(Photo. by Scientific American.)

forcement attached to the structural frame. The outside wall is usually 2 inches thick, but is highly reinforced in all directions by expanded metal or mesh

reinforcement which is completely imbedded in the concrete.

At this point we may add that a concrete gun is a device for spraying a rather liquid concrete on metal lath, wood lath, or a suitable surface. It is widely employed in concrete work, such as for lining tunnels, finishing the walls of buildings, and so on. It saves much time and labor and has proved a great boon in concrete work.

The interior wall in the plastered and concrete gun types of concrete houses is produced by plastering on expanded metal or mesh. Insulation against temperature changes is thus obtained by the dead air space between exterior wall and the interior plaster.

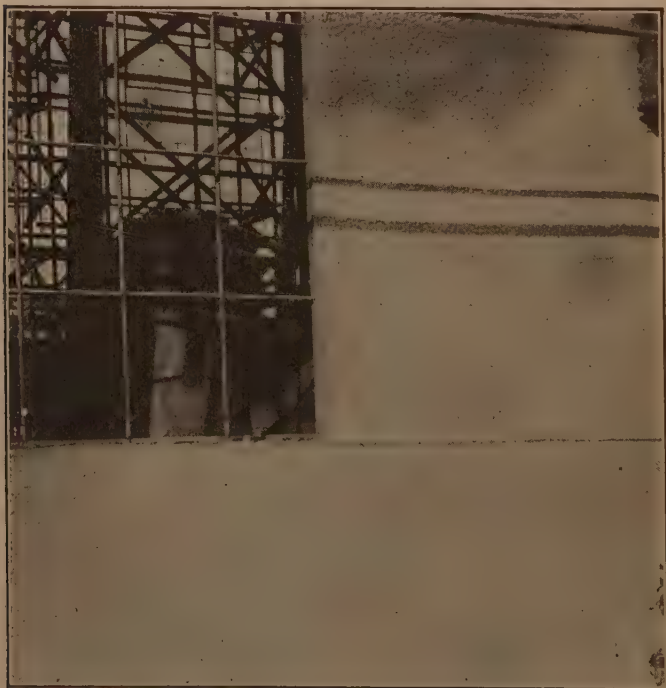
Results of such fire tests as are available indicate that a 2-inch concrete wall, reinforced with mesh or expanded metal, withstands the two-hour standard fire test. In the average dwelling there is not enough combustible material to produce a fire of sufficient intensity and duration to affect greatly this type of construction and favorable insurance rates are thereby justified.

All structural requirements are fully met in the plastered or gunite type of house as defined. For these reasons building codes should allow this type of construction within the fire limits of cities and insurance rates should credit in full this type of fireproof construction in all portions where concrete is used. Floors should be of concrete to produce a thoroughly fireproof structure, but this is not always desirable, as already pointed out.

Plastered or gunite concrete houses allow latitude of design so that the architect is not hampered by any predetermined unit in working out the design of his building.

The Donaldson system produces reinforced concrete floors and structural framework, with walls formed by plastering cement mortar on both sides to get a total

plastering and back-plastering on metal lath. Columns, beams and floors are cast in place, with the metal lath acting as forms. The outside wall is formed by fastening metal lath to the columns and beams and



Close-up view of wall and window frame, using the wire mesh and cement gun type of construction.—(Photo. by Scientific American.)

concreting to a thickness of about 2 inches.

The inside wall is also plastered on metal lath which is spaced about 3 inches from the outside wall, thus forming an air space between outside wall and plas-

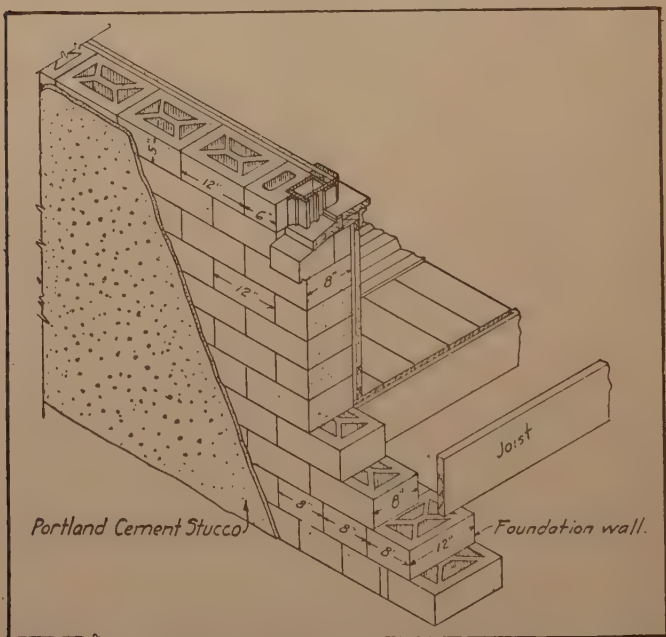
tered interior finish. Floors and ceilings are of concrete cast in place on rib expanded metal supported at intervals. Ceilings are finished by plastering on the expanded metal, which has previously served as forms for the concrete floor and ceiling slabs. This system has been used to construct houses in several American cities.

A method developed and advocated by Ballinger and Perrot, architects and engineers of Philadelphia, eliminates expensive forms. Concrete foundation walls are built in the usual manner first. Floor joists are set in place on the foundation wall. On these a wood frame, consisting of studs, joists and runners, is erected in the same manner as for a frame building. Every fourth stud is doubled, leaving a 3 by 4 inch space, which is filled with concrete to form a column. At the second and third floor levels, ledger boards with bottoms attached, are placed over the studs, so arranged that, when filled, a concrete beam is formed, which, with vertical concrete studs, makes a homogeneous concrete frame. When the studs and framework are completed, the outer surface is covered with a waterproof paper and expanded metal or mesh is stretched over the paper and stucco applied, either by a cement gun or by hand. This method was used to build houses at South Ardmore, Pa.

CONCRETE BLOCK AND TILE HOUSES

At present approximately 4,000 concrete products plants in the United States are working to supply the demand for concrete block and tile. These units have acquired a leading place in the building material field despite the criticisms and prejudices of the past. Block as first made was sometimes objectionable from the standpoint of appearance, due largely to the effort of beginners to imitate cut stone or some other form

of masonry construction. Also, the pioneers in the business had to contend with the many problems that always confront any new industry. The lack of knowledge as to what constituted the best methods of concrete block manufacture naturally resulted in the



Wall built of concrete tile which provide a dead-air space and which take a finishing coat of stucco.—(Courtesy of Portland Cement Association.)

production of a unit lacking the qualities of the later products made by improved methods.

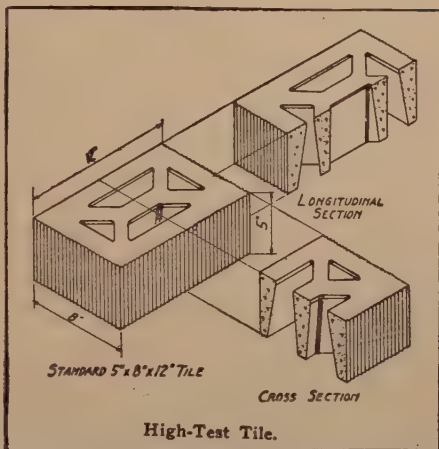
The importance of careful selection and proportioning of materials, the value of proper curing of the products and other essential practices were not fully

understood in the early days, yet houses and other buildings built of concrete block more than a score of years ago are in as good condition to day as when first erected. The durability and stability of these building units have been proved conclusively by the performance of these early structures.

Some of the factors which have contributed to the rapid rise in popularity of concrete block construction are:

1. The ready adoption by products men of the best practices of manufacture. In cooperating with the American Concrete Institute a rigid set of specifications has been prepared governing strength and absorption requirements. Block meeting these specifications must safely withstand an average load of 1,000 pounds per square inch with no test specimen falling below 700 pounds per square inch. Absorption above 10 per cent is not allowable.

2. Economy in manufacture and the ease, speed and low cost of erection. No great outlay of capital is necessary to build and equip temporary plants such as would be suitable to establish at points where extensive building operations are in progress. A well equipped plant operates the year round and a reserve stock of



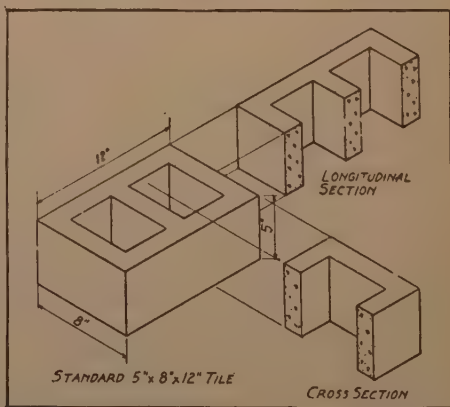
A popular type of concrete tile, which combines a dead-air space with great strength.
—(Courtesy Portland Cement Association.)

block may be made during the winter for the following summer's use. Speed of erection—a point always foremost in the minds of contractors and builders—is one of the chief advantages of these easily handled units. One mason and his helper have been known to lay from 400 to 500 eight by eight by sixteen inch concrete block, the equivalent of 5,000 brick, in an eight-hour day.

3. Low cost of upkeep. Once built there is practically no further cost for maintenance or repairs.

4. Permanence. Structures erected more than 20 years ago stand as proof of the durability of concrete block construction.

5. Insulation, fireproof and waterproof qualities. Practically all types of concrete block provide an air space in the wall. In making a hollow unit the manufacturer achieves a double purpose. He not only reduces the amount of material that would be necessary for solid wall construction, but also contributes toward the insulation necessary to insure a dry wall, producing a structure easy to heat in winter and keep cool in summer. Instances where concrete block houses have successfully withstood fire are sufficiently common to require no further comment.



Standard type of concrete tile. Either an 8-inch or a 12-inch wall can be laid with this tile.—(Courtesy Portland Cement Association.)

6. Adaptability to all classes of homes, whether built singly or in groups. Concrete block can be given a wide variety of architectural treatment and are suitable for all types of buildings from a small and unpretentious home to a stately mansion or institution. So numerous are the treatments to which the surface of these units may be subjected that they may be used for the construction of every house in a city block without repetition of surface texture or color. The design of every house in a community may be varied with these adaptable units without appreciably increasing the cost. The demand for a building material with which individuality can be expressed is fully met by concrete block.

Concrete block and tile used in house construction should meet the requirements of the standard specifications and building regulations of the American Concrete Institute.

For residence construction two types of block are advocated. One class includes those units having a facing containing special aggregate such as crushed granite, marble chips, colored sands and similar materials. Color and texture of the surface may be brought out by removing the cement film and thus exposing the aggregate by scrubbing with water or by some other approved method. The second class includes unsurfaced block and tile made purposely to receive a finishing coat of Portland cement stucco. Units made with a face to imitate cut stone or other forms of masonry should not be used because they are highly inartistic.

To obtain the desired color effects the use of selected colored aggregates is recommended as preferable to introducing mineral pigments.

The use of concrete trim stone and building ornaments is recommended to give concrete block structures a finished architectural appearance. Care should be

taken during erection to prevent exposed surfaces from becoming spattered with mortar. Any mortar which may become attached to the surface should be removed before the workmen leave the job.

It is recommended that the plaster be furred out rather than be applied directly on the inner wall surface. However, if the units are of such type as to provide a wall with a continuous air space entirely around the building and from foundation footing to plate, plaster may be directly applied on the wall surface. The use of two-piece sill courses, lintel courses and water tables is recommended so as to provide a continuous air space between the inner and outer sections. This space need not be greater than $\frac{1}{4}$ inch.

CONCRETE FLOORS

The many obvious advantages of concrete cellar floors make them the unquestioned choice in all good houses. There are even better reasons for building the upper floors of reinforced concrete construction, and the practice is growing rapidly. While the plans for concrete houses generally call for the usual wood floor construction, there will be no serious difficulty in changing to concrete floors in any of these houses—and this is to be recommended. Experience in modern residences has shown that concrete floors are not cold as commonly supposed. Over a heated basement the concrete floor has been found to hold the warmth in the winter time like the stones of a fireless cooker, actually feeling warmer than a wood floor. The concrete floor may be attractively finished and even provided with tile borders.

CONCRETE ROOFS

Concrete roofing tile are for sale in many cities at

a cost which makes them economical for even the smallest house. The permanent and fire-resistive qualities given to the roof are worth many times the cost, and the building is given a more substantial and finished appearance. It should be remembered that the asbestos shingle makes use of a large proportion of cement, mixed with asbestos fibre, so that it is, in a sense, a cement shingle. Concrete slab construction is recommended for the flat-roofed type of house which is often followed out in concrete construction.

The Portland Cement Association has published an attractive book entitled "Concrete Houses," which may be obtained at a cost of 50 cents per copy, and which contains a variety of exceptionally attractive designs for large and small concrete houses. Being especially designed with the use of concrete in mind, these designs should be given preference over other stock designs intended for other types of construction. If a special design of dwelling is desired, then care should be exercised in selecting the architect, for it is essential that the architect be familiar with the concrete type of dwelling and its architectural possibilities.

As the cost of lumber and carpentry work keeps on mounting, there is more and more opportunity for builders to turn to concrete. Even so, this type of dwelling has not received the attention which is due it. The excellent work done in concrete and loose stone by the well-known architect, Ernest Flagg, and described in our chapter dealing with the stone house, is bound to have a far-reaching effect in future home building.

In the no distant future we can expect some ingenious inventor to elaborate on present-day concrete building methods as applied to residence construction. Elaborate forms of wood or steel may even be replaced with nothing more formidable than light wood frames on which burlap or jute scrim has been stretched and

then sprayed with the cement gun, forming a rigid mold to receive and form the concrete batch. Such molds would prove far less expensive than the present molds of lumber, and would serve to reduce still further the cost of poured concrete construction.

The main beauty of the poured type of concrete construction is that it requires little equipment. A small concrete mixer, operated by a gasoline engine, will supply the concrete batches. Ordinary labor may be employed, just so long as the man directing the operations knows what he is doing. What a contrast with the usual constructional methods, calling for skilled carpenters or masons! The author rises to predict that the next few years will see more and more concrete dwellings, and that this method of construction will develop in a remarkable and quite unexpected manner.

CHAPTER XI.

THE ROOF—WHAT IT IS AND WHAT IT DOES

A HOUSE is no better than its roof. The walls may be of stone, the foundation may be exceptionally large and stable, the interior trim may be of the best, the heating system may be ideal in every way; but if the roof of the house is defective, the occupants of the house will lack protection from the elements. The roof is the main shelter which the house affords, after all is said and done.

Therefore the roof must receive due consideration in home buying and home building. Unfortunately, the roof only too often receives scant attention in buying a home, with the result that trouble soon develops and does much damage before the defective part is located and repaired. Again, in building a house the roof is one of the last items to receive consideration, with the result that the funds may be pretty well depleted by the time it is to be passed upon. As a consequence, the cheapest kind of roof is decided for what is otherwise a pretty good house. All of which is wrong, absolutely wrong.

KINDS OF ROOF—ARCHITECTURALLY SPEAKING

The question of the roof involves two main con-

siderations, namely, the design and the material employed. Considered from the point of view of design, the architect is concerned equally with the profile or contour of the roof as related to the building, and with the artistic effect obtainable from the roofing material which he selects. The home builder, on the other hand, while also concerned with the artistic effect, is most concerned regarding the service he is going to get from the roof. He is concerned with the longevity of the roof and the absence of repair bills, for he is concerned with the roof not for a week or month or year, but for many, many years.

While there is a great variety of roofs, the principal types, of which others are variants, can be confined to five, according to C. Matlack Price, author of "The Practical Book of Architecture," which are as follows:

1.—The Mansard Type. 2.—The Cable Type. 3.—The Gambrel Type. 4.—The Hip Type. 5.—The Flat Type. (See page 22.)

The mansard was widely popular in the design of dwellings of fifty years ago, and many examples, both good and bad, exist throughout the country today. The chief advantage of the mansard roof lies in its maximum utilization of space on the top floor, and its greatest failing appears when, through poor architectural treatment, the building looks top-heavy. This type, or a modification of it known as the combination hip or flat deck, is particularly adapted to large public buildings where a distinctly formal roof aids the design.

The gable roof is the plain pointed roof which is confined almost entirely to dwellings. Its effect depends upon the pitch of the roof, meaning its inclination or degree of steepness, and upon the skill with which dormer windows and chimneys are introduced to break its monotony.

The gambrel roof is a form of gable roof with two

different pitches. Its distinguishing characteristic is the shoulder, and the pitch from ridge down to shoulder and from shoulder down to eaves varies with different local types. A marked difference, for example, is apparent in the steep gambrel roofs of New England and the low, graceful sweep of the gambrel characteristic of the Dutch Colonial houses of New York State, New Jersey and farther south.

In the hip roof, four rafters run up diagonally from the corners to meet the ridge. This is the type of roof not so frequently seen in dwellings as the gable and the gambrel, but very frequently seen in large public buildings. Its symmetry from side or end commends it for use in architectural projects of a formal nature.

The flat roof, as its name implies, is a roof in which the element of design enters hardly at all. Roofs which are literally flat are usually only portions of roof, such as small deck areas, for even a flat roof usually has a two-way or one-way pitch sufficient to drain water to gutters, even though this pitch be so slight as to be hardly perceptible.

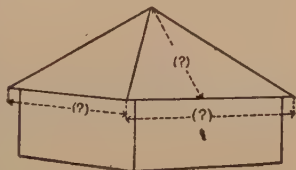


Fig. A. See text for roof measuring data.

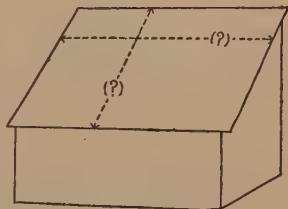


Fig. B. See text for roof measuring data.

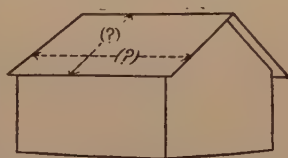


Fig. C. See text for roof measuring data. — (Sketches courtesy The Lehon Company.)

HOW TO ESTIMATE THE AMOUNT OF ROOFING NEEDED

Roofing is sold by the "square," which means enough to cover 100 square feet. Finding the number of square feet in a roof and dividing by 100 will give the number of "squares" needed.

Referring to the accompanying sketches, in Fig. A the type of roof shown is simply figured for the amount of roofing required. Multiply the length of the roof by the length of the rafters.

For the style of roof shown in Fig. B, multiply the length of the roof by the length of the rafters, then double this amount, which gives the number of square feet on both sides of the roof.

For the type shown in Fig. C, multiply the length of each section of the roof by the longest rafter in that section, and then divide by two. Measure and figure each section separately, as they may be of different size. Add the totals together and we have the whole amount required, in square feet. Obviously, the number in square feet is divided by 100, which gives the number of "squares" required.

To measure a roof from the ground, ascertain the distance from eave to eave. Add to this the fraction indicating roof pitch, as shown in Fig. D, and divide by 2 for length of rafter. Now multiply by length to get actual number of square feet on one side of roof, and add 10 per cent for ridging, valleys, starting strips, and waste. Multiply by 2 for total coverage. This gives the square feet. Divide by 100 to obtain number of "squares." For each dormer one "square" should be added, and more if the dormers are large.

No deductions should be made for apertures in the roof, such as chimneys, skylights, and so on. What these breaks save will be needed for "flashing"—turning up against adjoining walls or down under the

eaves. It is well to add 5 to 10 per cent extra for trimming.

THE PITCH, THE RAFTERS, AND THE SHEATHING

Insufficient pitch probably causes more troublesome roofs than any other single factor, especially in climates where there is considerable snow. It is difficult to build a tight roof of low pitch in these localities. In climates where the snowfall is very heavy, the pitch should be not less than one-third. Home builders, in the climates where deep snows are customary, will also do well to hold to simple, straight roof lines.

The roof rafters, the framing members of the roof, must be of sufficient size and strength to support the weight of the roof, to carry the snow load and to resist

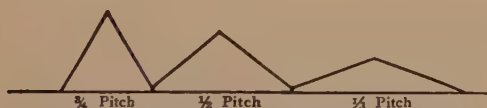


Fig. D.—Various pitches of roofs. See text for roof measuring data.—(Courtesy The Lehon Co.)

the wind pressure without sagging. If the rafters are undersized or spaced too far apart, they will sag. This sagging will split and loosen the shingles and cause a leaky roof.

The rafters, being spaced more or less apart, cannot take the roofing material directly. Some covering must be placed on the rafters, so that there will be a proper supporting surface for the roofing material. In the case of wood shingles, which are still quite popular, the practice is to place small strips of wood on the rafters. These furring strips are spaced a few inches apart and serve as a firm foundation for the

wood shingles, while exposing the underside of these shingles. Wood shingles are by no means water-proof so far as the surface of the shingles is concerned. However, these shingles have a remarkable absorptive power; so much so that even if a wooden shingle roof shows signs of daylight right through it as the result of old age, it may still be practically watertight because of the absorptive properties of the wood shingles. However, the shingles become quite wet at times and it is therefore necessary to have a free circulation of air reaching them on the under side.

Some builders prefer to use boards instead of furring strips. In this case narrow roof sheathing boards give better results than wide ones. Four-inch boards spaced two inches apart make the ideal roof sheathing since they allow the air to reach the under side of the shingles, keeping them dry and thus giving them a longer life. As the roof boards are depended upon for some bracing effect as well as to furnish the foundation for the roof covering, the joints should be staggered, that is, adjacent roof boards should not end on the same rafter. All joints should come directly over a rafter. All roof boards should be nailed with at least two 8 or 10 penny nails at each rafter. Boards wider than six inches require at least three nails.

So much for wooden shingles. When it comes to other kinds of roofing material, such as prepared roofing in rolls or shingles, copper and other metal roofing, slate roofing, and asbestos roofing, it is necessary to lay a sheathing of tongue-and-grooved boards over the rafters. This sheathing affords a good, solid foundation for the layer of tarred felt or roofing paper and the shingles.

THE VARIOUS KINDS OF ROOFING MATERIAL

Roofing is available in two general forms, namely,

rolls and shingles. The roll roofing is generally some densely-compressed all-rag felt which is coated with asphalt compound. This roofing is readily laid in strips, and therefore saves considerable labor as compared with shingle roofing. However, it is by no means attractive in appearance, and its use is therefore confined to barns, small factories, and other buildings where appearance is entirely of secondary importance. Sometimes it is used for small, inexpensive dwellings.

Shingles are single, small pieces of roofing, which are applied as units in some manner or another in order to obtain the entire roof covering. Shingles are made of iron, copper, zinc, aluminum, asbestos, tarred felt treated with crushed slate, slate, wood, and other materials. In order to save time and labor in laying roofs, some form of tarred felt shingles come in short strips made to represent the effect of several shingles. When properly laid such strips give the same general appearance as single shingles.

The most popular roofing today for small dwellings is the prepared roofing shingle, otherwise known as the bituminous roofing because bituminous material forms an essential constituent. The bituminous materials used for the purpose are the tar pitches, obtained as residues from the distillation of coal or oil tar, and the asphalts obtained either by softening certain refined natural asphalts with especially prepared petroleum oils, or as residues from the careful distillation of asphaltic base oils. From the standpoint of application, this class of roofing may be divided into the built-up type, in which the various materials are assembled on the building, and the prepared or "ready" roofing, which simply requires to be nailed or otherwise secured on the roof deck. The ordinary gravel-surfaced tar or asphalt roof is a typical example of the first class, while the prepared type is represented by the heavyweight saturated and coated felts or by

the "asphalt shingles." Certain kinds of roofing are, however, intermediate between these two types, such as the strip shingles already mentioned.

From the standpoint of fire risk, bituminous roofings are usually rated as less hazardous and require more consideration than is usually given. This fact is best illustrated by the ratings given such roofing by the Underwriters' Laboratories. When properly laid, the better roofings of this kind have been given ratings in Class A, the best rating given by the Underwriters' Laboratories. This Class A "includes roof coverings which are not flammable and do not carry or communicate fire; which afford a very high degree of heat insulation to the roof deck; which possess no flying-brand hazard; which do not slip from position when exposed to high temperature, and which are durable and do not require frequent repairs."

On the other hand, the "prepared" or "ready" roofings are usually rated as more hazardous and require higher insurance premiums. Some asbestos-felt roofings are rated almost as safe as the built-up type of roofing and some "asphalt shingles" as less hazardous than other types of "ready" and prepared roofing.

From the standpoint of serviceability, bituminous roofs vary greatly. Some of the "prepared" types show a life of but three or four years, according to the Bureau of Standards, for which the author is indebted for much of the material on bituminous roofing, while a "built-up" roof composed of the best materials and laid with careful workmanship should last from 15 to 30 years, and not a few cases are on record where such a roof has stood for over 40 years without necessitating any extensive repairs. Failures are not uncommon but are usually chargeable to poor workmanship. The "prepared" types, with the exception of the "asphalt shingle," are, for the most part, used on temporary or, at most, semi-permanent structures, while the "built-

up" roofing is used on most large permanent buildings.

The question of appearance is so largely determined by personal taste that no definite distinctions can be made. The "built-up" types are usually constructed from the standpoint of service, with appearance as a secondary consideration, though such a roof is frequently covered with vitrified-clay tile when appearance becomes an important factor. Certain two-ply asbestos felts are now being made by saturating and coating one sheet of the felt and rolling into this coating a second sheet which is unsaturated. This leaves one white side, and the felt is laid with this side exposed, thus presenting a pleasing appearance. Pleasing architectural effects are often obtained with the "prepared" type by the use of molded wooden battens over the joints of the roofing or more especially by the use of the "asphalt shingle."

These bituminous roof coverings, even of the "built-up" type are by no means the most expensive materials which can be used, and many of the "prepared" or "ready" roofings are less expensive than wooden shingles in most localities. If a "built-up" type of roof is properly laid, the cost of maintenance is, perhaps, as low as any roof that can be laid. The "ready" or "prepared" roofings, though they do not, for the most part, show a serviceability of many years, are yet frequently an economical roofing and even the cheapest of them may at times be used to advantage on temporary structures.

COMPARISON OF TAR AND ASPHALT FOR ROOFING

"Built-up" roofs of both asphalt and coal tar have been used with considerable success throughout all parts of the country. Asphalt is somewhat less affected by temperature changes and may be used on somewhat steeper slopes, but except for this it has few advantages

over the coal-tar pitch, which, as a rule, is much less expensive. It is essential that asphalts be not heated too hot, either in the process of preparation or application, as such overheating will ruin the best material and is likely to result in the scorching of the felt to which it is applied. Likewise, coal-tar pitch should not be overheated or kept at a higher temperature than necessary for too long a time, because such heating, in addition to the possibility of scorching the felt, acts as a distillation process and unduly hardens the pitch. Blown oils, or "blown asphalts," as they are called, are not the best for holding the stone surfacing, because of their lack of adhesiveness.

The raw felts employed for the saturated felts of roofing are made on a paper-making machine and, for the most part, are composed of torn-up cotton-rag stock, to which is added more or less jute, old paper stock, etc. The felts thus made are passed through a vat of hot tar pitch or asphalt, by which they become saturated. The term "wool felt" as applied to these felts is a misnomer, for rarely does more than 10 per cent of the fibre consist of wool, and more often the only wool present is incidental in the none too carefully selected cotton-rag stock that is used. Felts of asbestos fibre are also made and impregnated with asphalt in a like manner. Woven fabrics of jute and cotton are manufactured for special purposes where strength is all-important, but many of them are of doubtful value except under peculiar conditions.

Tar-saturated felts come in rolls 32 to 36 inches wide and, as a rule, weigh about 14 to 15 pounds per square (108 square feet; in general roofing, 100 square feet constitute a square, but the felt manufacturers allow 8 square feet for lap and sell 108 square feet of felt as one square), though other weights are to be had. Asphalt-saturated felts also come in rolls of the same width and are to be had in almost any desired weight.

For a "built-up" roof of five-ply or over a minimum weight of 14 pounds per square seems about what should be required, while if the roof is to be less than five-ply a heavier saturated felt should be required, while if the roof is to be less than five-ply a heavier saturated felt should be required which will weigh not less than 25 pounds per square. Sometimes felts coated, as well as saturated, with asphalt are used. This coating is accomplished by passing the saturated felts over a set of rolls and playing on one or both sides a stream of hot asphalt. It is customary in such saturated and coated felts to dust on the coated surface some powdered soapstone, fine sand, cork dust, or like material to prevent sticking together in the roll.

Few criteria can be given for selecting a good felt for roofing. Most manufacturers place on the market, for competitive purposes, one or more brands which are made of very little rag stock and are largely composed of the cheaper jute, ground wood, old newspaper stock, etc., so one can not hope to get a high-grade article if he is seeking for the cheapest material of the kind on the market. Other things being equal, the best felt is the heavier and the more uniform product. It must be strong enough to stand handling and must be suffic-



Method of applying composition shingles on matched boards to form a tight roof.—(Courtesy of prepared roofing manufacturers.)

iently pliable to bend double without cracking. A portion of the felt torn apart and examined with a good hand magnifying glass should show a thorough saturation of the fibres, and none of them should present a clean or yellow appearance. This appearance of the fibre does not apply to asbestos felts, since asbestos does not absorb bituminous materials.

Asbestos felts are sometimes used with asphalt for roofing, but so far do not seem satisfactory for use with coal-tar products. Asbestos fibre does not absorb the bitumen, and the felts can not be said to be saturated with asphalt. This type of felt has not been in use for as long a time as have the rag felts, and while the asbestos does not decay the wearing properties of sheet asbestos are questionable, especially since it is not customary to protect them by a gravel or crushed-slag coat. The blanketing influence of such a felt on fires within the building is a point which has probably been overestimated. Such a roof is lighter than the ordinary "built-up" type, but this lightness lowers its heat-insulating qualities and on wood sheathing seems to more nearly approach for first-class work the conditions met in ready or prepared roofing. For these and other facts in connection with bituminous roofing, the author is indebted to the Bureau of Standards Circular No. 70, dealing with household materials.

CONSTRUCTION OF THE BUILT-UP ROOFING

This type of roof is of value only on roof decks of little slope and is not advisable where the incline exceeds 3 inches to the foot horizontally. Such a roofing may be laid on either a concrete or wooden roof deck, but it is essential that the roof deck should be reasonably smooth and, if it be made of wood, that it be free from wide cracks and that all knot holes be covered, preferably with pieces of sheet metal. It is adaptable

either to coal-tar pitch or asphalt used with a felt saturated with a like material. If coal-tar pitch be used on a wooden roof deck, it is advisable that the roof deck should first be covered with a good grade of sheathing paper, to prevent any coal-tar pitch from "cooking" through the felt and ultimately finding its way into the interior of the structure and also to protect the coal-tar pitch against drying out from below. If asphalt is used, this detail is not so important as with coal-tar pitch. Sheathing paper is not necessary in case of a concrete roof deck. In laying this type of roofing it is essential that each layer of felt be smoothly and evenly laid and that all joints should be so lapped that in all places there will be the specified number of layers of felt on the roof. The felt should be so uniformly and thoroughly saturated with hot coal-tar pitch or asphalt that in no place shall felt touch felt.



How a tight and waterproof joint is effected between chimney and roofing. Note the flashing.—(Courtesy of prepared roofing manufacturers.)

If there is any possibility of wind disturbing the roof from underneath, the felt may be secured in place by the use of a few well galvanized, large-headed nails, but care should be exercised that all nails be covered with at least two plies of felt. The felt should be turned up against all adjacent vertical surfaces and properly cemented to the same. Proper flashing must be provided if one would expect to get a satisfactory and lasting leak-proof roof. The flashing is a lap joint of metal or other material to keep the roof water-tight where it joins a chimney, wall, or other vertical surface.

When the last layer of felt is laid and the flashings are in place, the entire roof surface should be covered with a thick layer of hot pitch or asphalt, as the case may be, and while this is still warm at least 400 pounds of clean, dry, washed gravel or 300 pounds of crushed slag per hundred square feet of surface should be embedded in this pitch or asphalt. This gravel or slag should consist of pieces from $\frac{1}{4}$ to $\frac{5}{8}$ inch in size and be free from sand or dust. The gravel or slag layer is not so essential in the case of a roof built up with asbestos felts, but when the ordinary felt is employed the use of slag, gravel, or tile is almost imperative.

"READY" OR "PREPARED" ROOFING

The "ready" or "prepared" bituminous roofings are of the same general type and made of the same materials as the saturated felts described as felts for the "built-up" roofings, except that most of these "ready" or "prepared" felts are coated with bitumen and, in addition to being saturated, are usually surfaced with some ground mineral substances or other material to prevent sticking in the roll. With the exception of the shingle type and a few others, these materials come in rolls of one or two squares, and are usually accompanied by the nails and the cement necessary to lay them. They vary from the lightest felt, made in the most inexpensive manner and of the cheapest materials, to a several-ply sheet so heavy that it can not be rolled. They are made either with coal-tar pitch or asphalt, but, since in the case of coal-tar felt, if it is to be put up in rolls, it is not possible to coat the felt and avoid the layers sticking together, the coal-tar products do not enter greatly into the field of "ready" or "prepared" roofing, except in so far as ordinary saturated tar felt is used for very temporary

structures. The cement which accompanies many of these "ready" roofings consists usually of an asphalt or mixture of asphalts dissolved or thinned with a petroleum distillate, though sometimes a cement is furnished which can not be dissolved in any solvent but which is calculated to be used hot.

These "ready" or "prepared" roofings which come in rolls have certain inherent weaknesses which would prevent their use on many permanent buildings. One of these weaknesses is the fact that, despite all care to lay them properly, they frequently stretch or wrinkle after being exposed on the roof for some time, thus resulting in a bagging of the felt. As time goes on and the saturant hardens, these wrinkles become weak spots, especially if they are walked on or abused in some way. Another source of weakness is the fact that, except for the narrow lap, the roof deck is covered with but one layer of the material, which is not desirable, because in addition to other objections, such a roof has neither great heat-insulating properties nor great fire-resisting properties. Again, if the roof deck be rather flat, it is possible for water to be backed up under this lap and pass through the sheathing into the interior of the building. If the roof deck be of wood and knot holes and cracks are not covered with sheet metal or otherwise cared for, these become sources of imperfection, and above them the felt may be readily broken through. If a tear starts at any point and the wind is allowed to get under the felt, its light weight makes it possible to be torn from the roof with little resistance.

Asbestos-impregnated felts are also made for this purpose, sometimes of several plies of felt and, in some cases, reinforced with a woven fabric in the interior of the felt. Some of the heavier brands are quite expensive and often approach the cost of a five-ply "built-up" roofing. While the asbestos will not burn, the

average thickness of these felts is such that the heat-insulating value is not great. From the standpoint of fire protection they are generally overvalued, in the opinion of the Bureau of Standards.

In general, the heavier the felt, the more satisfactory is the material. The manufactures frequently designate the thickness of the felt by the number of ply, but lack of uniformity of practice makes this designation inconsistent. With some manufacturers a two-ply felt means two separate felts cemented together with a bituminous material, while with others it means simply that a two-ply material is heavier than that sold as one-ply. The weight of a felt is most often designated by number, meaning that the felt weighs that number of pounds per 480 square feet. (Paper scales were originally built for a 480-sheet ream, and on weighing a 1-square-foot sheet the weight per 480 square feet would be read directly on the beam). For example, a No. 55 felt weighs 55 pounds per 480 square feet. The saturant should be of such consistency that it is workable at a temperature low enough to preclude possibility of damage to the felt by scorching, and, at the same time, the felt after saturation should remain pliable and not liable to fracture on quick bending; but this detail must be left to the manufacturer, who should know the properties of his material. The coating should be stable and not easily affected by the wind or sun and must retain its life and elasticity or the roofing is a failure. Frequently—that is to say, once every year or two—it is advisable to coat an asphalt-felt roofing of this kind with a good grade of asphalt paint to revive this coating and keep it in good condition. The mineral surfacing, while giving an added weight which should not be considered in judging the weight of the material, has advantages which make it desirable in many cases.

Since there are so many low-grade materials on the

market, and so few criteria for judging the quality, except by service test, and since guarantees are uncertain, the consumer must, to a great extent, rely on the honesty and reputation of the manufacturer to secure a high-grade article.

APPLICATION OF "READY" OR "PREPARED" ROOFING

These felts may be laid in a variety of ways. The most common method is to lay the sheet parallel with the eaves, starting at the bottom of the roof. The sheet must be stretched to avoid wrinkling or bagging. Cleats or heavily galvanized nails with large heads are recommended, and care must be exercised that the nails are never driven into cracks. Tin caps are not believed desirable, because of the tendency of these tin caps, when not consistently coated, to disintegrate through the corrosion of the iron or steel base of which they are made, thus allowing the nails to stand high and clear of the roofing, so that the felt is easily torn by high winds. The next layer of felt is allowed to lap 2 or 3 inches over the first layer, and prior to nailing the lap should be coated with the cement into which the new layer is imbedded. Care must be taken to provide proper flashing, well secured, about all vertical surfaces.

The felt may also be laid with the pitch of the roof, and this is of advantage in that it permits felt to be better stretched before being secured to the roof deck. For architectural effect, when the felt is laid with the pitch of the roof, wooden battens may be used over the laps, resulting also in a better protection of the felt against the possibility of being torn by high wind.

"PREPARED" ROOFING IN SHINGLE FORM

Some of these "prepared" roofings heavily surfaced

with coarse sand or crushed slate are cut up into shingles of various sizes. One size in common use is 8 by $12\frac{3}{4}$ inches. This shape of shingle is laid American style as ordinary wood shingles. Another common "asphalt" shingle is approximately square, with two of the corners cut off at an angle, and is laid according to the French or diagonal method. For the most part, these shingles are used on the smaller buildings, particularly dwelling houses, and from an architectural standpoint they present a pleasing appearance when freshly laid. They are not satisfactory for slopes less than 3 inches to the foot horizontally. Such shingles have not been in general use a sufficient time to judge what may properly be expected of them. Some such roofs which have been laid for less than five years present an unsightly appearance, due principally to the tendency of the shingles to curl but in part to the tendency of the mineral surfacing to become detached from or enveloped by the bituminous coating when the latter is softened by the heat of the sun. Some manufacturers of such shingles give an explicit guarantee to the effect that their shingles will not curl, and this feature is well worth looking into.

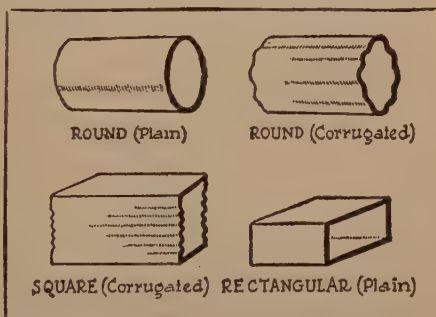
The sketch on page 267 shows the standard method for laying the "prepared" or composition shingles. The manufacturers of such shingles advise that the roof deck should be built up of well-seasoned lumber, not less than $\frac{7}{8}$ inch thick, dressed to uniform thickness. The boards should be laid in close contact and nailed securely to each rafter with not smaller than 8 penny cement-coated nails. On old roofs, if the boards are spaced, lumber of the same thickness as the boards should be nailed between them so as completely to fill the spaces. Composition shingles may be laid directly over old wooden shingles after nailing down or cutting away any warped butts.

The valleys and gutters must be laid in two overlapping courses composed of slate roll roofing. Sheets of half width (cut in two longitudinally) and full width for the lower and upper courses respectively, should be used. The lower sheet is fastened with nails. The upper sheet should preferably be in one length, and must not be nailed, being held in place over the lower sheet by means of lap cement. The adjoining courses of shingles are extended over the upper sheet to form a tight, waterproof joint.

GENUINE ASBESTOS SHINGLES

Only too often the term asbestos shingles is applied to flexible asphalt shingles with a base of rag felt. There is a flexible asbestos shingle, however, which is an improved all-mineral form of the flexible, slate-surfaced shingle. Its felt base is a fabric of asbestos rock fibre—a mineral that is practically as old as life on earth and

that has resisted the destructive forces of time for centuries, proving that it is immune to rot and weather. The difference should be carefully noted between the asphalt shingle which has a base of rag felt, composed of rags and, in some cases, partly jute, waste paper and other refuse materials. The base of the asbestos shingle, on the other hand, is a rock fibre absolutely



Four standard forms of leader pipes, which are obtainable in various sizes. —(Courtesy Copper & Brass Research Association.)

fireproof and immune to disintegration. The slate surfacing is the same in both types, but in the asbestos shingle the only function of the slate is to provide an attractive, colorful surface rather than to furnish protection for the felt, as asbestos felt is independent of slate surfacing for its resistance to time, fire and weather.

These flexible asbestos shingles, like the asphalt shingles, come in individual shingles as well as strips cut to simulate three or four shingles. The strip shingles are quicker and easier to lay and require fewer nails.

Then there are rigid asbestos shingles that are virtually as everlasting as the stones in the field, formed, as they are, of asbestos fibre and Portland cement united together under great hydraulic pressure. They are naturally impervious to all those agents of destruction and decay which affect roofing or organic material. They never need painting or refinishing of any sort and experience shows that they call for the minimum of up-keep expense. The first cost is considerably more than that of the bituminous shingle, but the rigid asbestos shingle must prove a wise investment in the long run.

Rigid asbestos shingles are obtainable in several colors so that the roof may be made any desired color or, better still, the colors may be mixed and blended so as to obtain beautiful color effects for architectural results. The shingles are obtainable in the oblong form and other forms for various effects.

THE SLATE ROOF

Slate as a roofing material dates back to the distant past. It has been used as the roof of many of the oldest buildings in Europe, and free use has been made of it in this country, where the slate industry

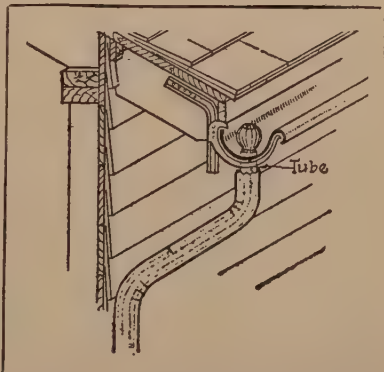
is about a century old, having been started in Pennsylvania, then in Vermont. Slate is also found in Maine, in Maryland, in Virginia, and also, but not in commercially important quantities, in certain Western States. Pennsylvania and Vermont produce about 90 per cent of all the slate quarried in this country.

Pennsylvania produces greys, blue greys and weathering greys exclusively. In commercial grades they are still known in some localities as "black" slate, a misnomer founded on their contrast with the very light greys or greens of Vermont. Vermont produces colored slate: purple, green and blendings of the two, an excellent slate assuming brownish colors. Red slate is mined exclusively in New York State, within a few hundred yards of the Vermont slate belt.

Slate shingles make an excellent roof, high in first cost but of lasting economy in the long run. There is virtually no upkeep cost with a slate roof.

Beautiful architectural effects may be obtained through the use of slate roofing. It goes without saying that slate withstands weathering and is fireproof.

Slate roofs are generally made up of thin shingles, but there are also available exceptionally thick shingles of large size and uneven shape and thickness which are employed to obtain exceptional architectural effects. The greatest strength of the roof being over



Detail of trough and leader. Note the strainer which prevents leaves from clogging leader.—(Courtesy Copper & Brass Research Association.)

the walls, thicker and heavier pieces are often placed at the bottom, and the thinnest at the top, giving a pleasing, graduated effect. The final result is a wonderful thatch of stone, in keeping with the time-resisting material and construction which generally marks the rest of a building provided with such a roof.

For the usual slate roof a sheathing should be provided over the rafters, made up of boards not over 8 inches wide and $\frac{7}{8}$ inch thick, of the tongue and groove kind. This sheathing should be covered over with roofing paper well lapped, laid to shed water and in undamaged condition when the slate is applied.

SHINGLES OF TIN

From slate we pass on to the several kinds of metal shingles, beginning with the tin roofing which is still very much in use. For residential purposes tin roofing is generally used in the form of shingles. The best kind of roofing tin carries on its surface a coating of 75 per cent lead and 25 per cent pure tin, approximately $2\frac{2}{3}$ pounds being deposited on each square, or 100 square feet. Some shingles are galvanized by being dipped in molten zinc, the tinned sheet absorbing the hot zinc and forming an amalgamation with the tin coating, so that 20 to 22 pounds per square cling to it. Aside from the tinned and galvanized metal shingles, there are painted tin shingles which are not so expensive but require occasional painting, thus adding to the upkeep costs.

Tin shingles come in various sizes and designs so as to make up any desired form of roof. The shingles are provided with some form of locking joint to ensure a weather-proof locking effect.

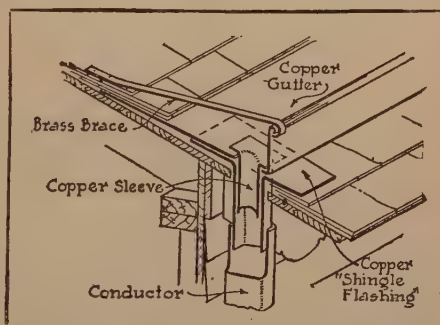
In addition to tin roofs formed with shingles, there are also tin roofs formed with sheets of considerable

size. These sheets are joined together by soldering, mechanical locking of the adjacent ends, or even a form of standing seam. For sheet metal work and tin roofs of this kind no better paint has been found than metallic brown, venetian red, or red oxide paint, ground in pure linseed oil. These paints have been used from time immorial, with eminently satisfactory results.

ALUMINUM ROOFING

Reduced cost of manufacture, constantly broadening the commercial uses of aluminum, has made possible aluminum roofing, which is at once permanent, pretty, and without maintenance cost. This roofing is said to be fireproof, rust-proof, weather-proof, hail-proof, water-proof, acid-proof, buckle-proof, sweat-proof, and a protection against lightning when properly grounded.

The two outstanding qualities of aluminum make the metal available for roofing purposes, namely, its lightness and the great resistance it offers to the elements. Made in the form of shingles, aluminum roofing is readily applied. As in the case of most metal shingles, aluminum shingles are provided with locking devices so that all the shingles are interlocked into one substantial roof.



Detail of method employed in making a watertight joint between gutter and leader.—(Courtesy Copper & Brass Research Association.)

The outstanding peculiarity of the aluminum roof is its light weight. It is well known that aluminum is the lightest metal in practical use. Compared with slate or tile, aluminum is but a feather in weight. Aluminum roofing weighs only 40 pounds per square, or approximately 4 per cent that of tile and about 7 per cent that of slate. This suggests immediately the saving of material in roof construction and throughout the building. Another point in this connection is re-roofing. Generally the roof supports of a residence are not strong enough to carry a heavy high-priced roof covering over the old shingles. With aluminum shingles it becomes possible to re-roof without adding any appreciable weight to the roof structure.

COPPER ROOFING

Of late years there has been an increasing tendency to use copper for roofing purposes, especially in the better types of dwellings. Copper is made into sheets of almost pure metal, the impurities being less than one tenth of one per cent. It is purer than most other metals as they are ordinarily manufactured for industrial purposes, and is less active chemically than any but the noble metals. This immunity to chemical attack insures a high resistance to corrosion by air, water, acids and other agencies. In comparison with other metals its endurance may be counted by decades rather than years. For strength coupled with ductility, it is unexcelled.

There is no maintenance cost for the roof of copper, because it requires no paint and it is impervious to the elements. Its first cost is its only cost, and even this is less than the cost involved in the roof of slate or tile.

A distinct factor of economy in the roof of copper lies in its light weight, which permits light instead

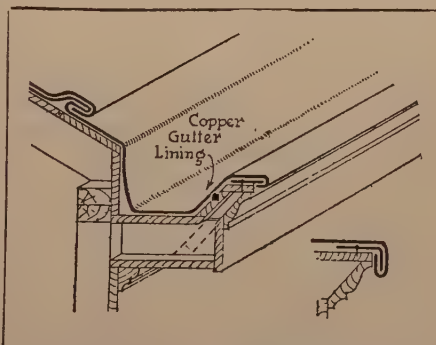
of heavy roof framing. The following table, prepared by the manufacturers of copper shingles, affords an interesting basis for comparison of the relative weights of seven types of roofing as compared with two types of copper roofing:

Material	Weight per 100 sq. ft. laid	
Shingle Tile	1200—1800	pounds
Spanish Tile	650— 850	"
Slate	450— 675	"
Felt and Gravel (or Slag)	400— 625	"
Asbestos Shingles	300— 650	"
Hardlead Sheets	210— 325	"
Wood Shingles	200— 300	"
20 g. Galv. Iron (Corrugated)....	— 225	"
16 oz. Copper (Standing Seam) ..	— 125	"
Copper Shingles	84— 100	"
Tin	— 75	"

The saving in the structural cost of the framing is thus apparent and demonstrable.

There are four methods of laying copper roofs, three using sheet copper and one copper shingles.

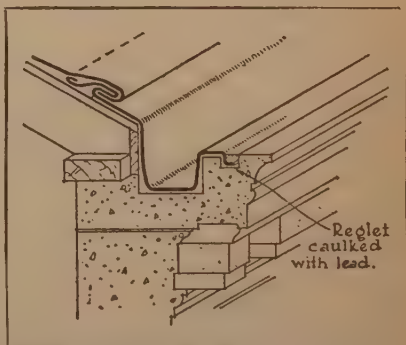
The Batten or Ribbed type has, as its salient feature, evenly-spaced battens or ribs running with the slope of the roof. These ribs are usually about two by two and one-half inches, with sides beveled, and are spaced about



Detail of copper-lined gutter wood cornice.—(Courtesy Copper & Brass Research Association.)

twenty inches apart. The roof is made of soft copper worked over the battens.

It is not the least expensive type, for obviously it uses more copper and requires more labor than other types. It has in its favor dignity, character and beauty, and by its very construction safety provides against expansion and contraction. On large steep roof areas, such as mansards and gables, for public buildings, churches, or large residences, it gives dignity and character to the structure, lending itself readily to any scheme of ornamentation.



Detail of how a copper gutter lining is secured to reglet in cornice.—(Courtesy Copper & Brass Research Association.)

The second type of copper roof is the standing seam type. Here the construction of the seams

amply provides for movement of the metal, due to changes in temperature, and successfully avoids that monotony characteristic of large roof areas poorly treated. This type, it can readily be appreciated, is somewhat similar to the batten type and has certain advantages over it: it is less expensive and can be used artistically on smaller buildings having flatter roofs. Like the batten type it can be used on roofs with steep slopes.

The flat seam or third type of copper roof requires a soldered joint. This type of construction is used on flat areas such as porch roofs, mansard tops, flat wide dormers and entrance canopies.

Another form of copper roofing is copper shingles. These are made from tempered copper sheets in a large variety of sizes and designs. The method of application is simple. Each shingle is secured to the roof sheathing by copper nails and laps over the adjoining ones in such a manner as to form a water tight joint. No soldering is required. No allowance for expansion is necessary, as the form of the shingle provides ample room for movement.

Copper shingles can be laid equally well on new roofs or over old shingles. Because of their raised-butt construction they are lifted slightly, thus providing an air space beneath the surface and the roof sheathing, allowing perfect ventilation with consequent coolness in summer.

Copper shingles are light. A roof as covered weighs only one-ninth as much as slate and one-third as much as wood, according to the claims of the Copper & Brass Research Association, to whom we are indebted for this data on copper roofing. This feature means a real economy in structural framing as already mentioned.

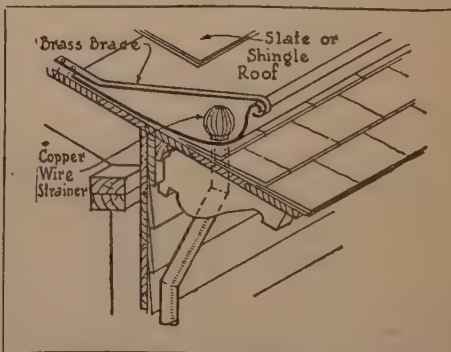
Every roof requires flashings, which should always be of copper. These are pieces of metal used at places where breaks in the roof surface occur, as at the chimneys, dormers, or where a change in direction of the roof surface forms a "valley" down which rain water flows to the gutters, or where the roof ends against a vertical wall or joins another as a dormer roof does the main roof. At these places it is necessary to cover the joint, and the piece of copper by which it is done is given the name of flashing. Every good roofing contractor knows how to flash properly, and if copper is used no breaks are possible at the joints.

Copper has a peculiar advantage over other metals used for roofing in that it contains in itself all the

requirements of decoration. Left alone it gradually weathers to a soft green tone; or it can be oiled and left to mellow to that dull bronze color which is seen only in copper. In the form of shingles it can be specially treated to obtain varied and beautiful effects in harmonious colors which range through autumn reds, russet browns, olive green, verde antique and emerald greens, blue greens, and even a rich peacock blue.

GUTTERS AND LEADERS

The water that falls on the roof in the form of rain must be drained away. Naturally, this calls for a certain "pitch" for every part of the roof—a slope down which the water can roll. Instead of permitting the water to drip off the edges of the roof, the water is gathered in a trough which is called the gutter. This gutter takes various forms—sometimes it is in the form of a slight wall near the edge of the



Another arrangement for the roof gutter and leader.—(Courtesy Copper & Brass Research Association.)

roof, which serves to guide the water down towards a leader pipe which takes it to the ground or the sewer. Sometimes it is in the form of a channel let into the cornice of the roof. Again, it may be in the form of a hanging channel. However it may be formed, the purpose is to gather the water and lead it to the leader pipes which take care of it after that.

All outlets from roofs or gutters should be covered with an approved type of wire strainer, otherwise leaves are apt to get into the leaders and choke them, causing no little trouble.

The leaders should be of ample capacity to drain the gutters to which they are connected. While all kinds of elbows are available for leaders, it is desirable to run the leader pipes as straight as possible. When leaders are not connected to sewer, they should be provided with heavy goosenecks or shoes at the bottom. Leaders should be held in position 1 inch clear of walls by approved fasteners. It is recommended that not more than 20 feet of pipe shall be soldered in one length. Leader pipe, of light-weight metal, is made so that one length can be driven into the next, if desired, and soldering is not absolutely necessary, although it is desirable.

Where tubes are used to connect gutters to leaders, a special flashing consisting of a "shingle flashing" with a sleeve soldered thereto, should be inserted in such manner as to be under the gutter and inside the leader so as to prevent any leakage around the joint made by the gutter and the outlet tube.

Gutters and leaders are generally of galvanized iron, although of late there is a growing tendency to use copper. Galvanized iron gutters and leaders last for a varying period of time, but eventually become rusted and worthless. Copper, on the other, is virtually ever-lasting, and while the first cost may run as much as three times the cost of galvanized iron, it proves a good investment in the long run.

Some thought should be given to the lower end of the leaders. Wherever possible it is advisable to connect them with the sewer, so that the rain water will be drained off as rapidly as possible. Where it is impossible or not feasible to make connections with the sewer, it is well to have the leader pipes discharge

where no great harm can be done by the water. Only too often this matter does not receive attention, with the result that heavy rainstorms cause serious erosion of the ground near the house and, in some cases, cause water to seep into the cellar. It is far wiser to use a few more feet of leader pipe and lead the discharge to a point where the water can be readily absorbed by the soil or led away from the house without spoiling the grounds through erosion.

CHAPTER XII.

THINGS THAT GO TO MAKE THE INSIDE OF THE HOUSE

THE house is by no means complete once the foundation is laid, the walls finished, the roof put on, and other externals attended to. There still remains the task of converting the interior of the box thus built into a livable home. Thus we need windows and doors and plaster or other form of interior walls, trim, floors, hardware, and so on.

THE QUESTION OF INTERIOR WALLS

The interior walls of the house can take a number of different forms. Thus we have plaster walls, which have long been the favorite form and still are more or less the real standard, although there is a growing tendency to use composition panels of various kinds instead of the usual lath and plaster.

The manner in which the inside walls of a house are covered is a matter of no little importance in determining the market value of the structure. By the careful observer wall plasters are judged on two distinct bases—artistic and structural. Of course, if the walls

are to be papered, the color of the plaster is of minor importance. If paper is not used, the plaster may be tinted to suit the taste, but care must be exercised to see that the color is uniform throughout the room. Whether papered or not, the plaster should have a plane surface, free from cracks. A wavy surface on a tinted or a papered wall, will reflect the light unevenly and make it appear as though the color is not uniform.

For warehouse construction it is necessary that the plaster be able to withstand hard knocks. For the ordinary house, however, no great strength is required of the plaster, provided that the surface does not rub off. When placed on wood or metal lath, plaster has an important structural function in protecting these materials from excessive atmospheric changes. The ability to act as a retarder of fire may be of some advantage. Probably the most important property of a wall plaster is its ability to absorb sound.

In all wall construction the cost of plaster itself is only a small fraction of the cost of applying it. Other things being equal, that plaster which works most freely under the trowel and can, therefore, be applied with least labor is to be preferred for economic reasons. This is so important that it is frequently advantageous to sacrifice in some degree the properties desired or to pay a much higher price for the plastering materials in order to keep the labor cost within reasonable limits.

The properties attained in a plastered wall depend upon three factors of about equal importance—the construction of the wall, the method of application of the plaster, and the quality of the plastering material.

THE BACKING FOR THE PLASTER

Plaster may be applied to almost any kind of a wall. The types of construction chiefly used are wood lath, metal lath, or masonry, such as concrete, terra-cotta

tile, brick, plaster board, etc. In all cases the walls (and ceilings) must be so designed as to be practically rigid under the loads they are expected to carry. Plasters can hardly be called elastic, so that any slight motion, such as might be caused by the settling of a wall or by a sudden jar or too heavy a load on the ceiling, will be apt to crack the plaster. Wood lath should be spaced about $\frac{1}{4}$ to $\frac{1}{2}$ inch apart, in order that the plaster may be pushed in between them to form a good bond. They should be thoroughly wet and should be permitted to swell before the plaster is applied; otherwise they will absorb water from the plaster and, hence, swell and cause cracks. Metal lath should be fastened to the wall in such a manner as to make it as nearly rigid as possible. Masonry walls should be very rough, in order that the plaster may have something to cling to, and should be wet, to keep them from absorbing water from the plaster. Special plaster base such as Bishopric may also be used to advantage.

APPLICATION OF PLASTER

For best results plaster should be applied in three coats, which are generally known as scratch, brown, and finish coats, respectively. The scratch coat is applied first. It is designed to form the bond between the wall itself and the body of the plaster. It is pushed into the apertures in the lath or the indentations in the masonry, and the exterior surface is roughened by scratching it with a special tool, in order that the next coat may adhere better. The brown coat forms the main body of the plaster, which is generally $\frac{3}{4}$ to $\frac{7}{8}$ inch thick. The finish coat is applied to give the wall a plane surface of the desired color. For the best results each coat should be allowed to set until quite dry and then should be thoroughly wet before the next coat is applied. The change in volume of wood lath

when alternately wet and dry will probably cause cracking of the scratch and brown coats. The cracks can be filled in before the finish coat is applied, but the brown coat must be sufficiently thick and dry to prevent the water used in applying the finish coat from penetrating to the lath.

CHARACTERISTICS OF THE VARIOUS PLASTER COATS

It is evident that the plastering material used in each coat must fulfill different requirements. The most important property of the scratch coat is strength. In the brown coat strength is of secondary importance to plasticity. The finish coat must be extremely plastic, must have sufficient strength to resist ordinary abrasion, and must have the desired color and surface finish. Since the brown coat forms three-fourths of the total volume of the plaster, the cost of material is of greater importance in this coat than in the other two. For these reasons it is customary to use for the three coats plasters of different compositions.

Plasters for scratch and brown coats consist essentially of some cementing material, such as Portland cement, Keene's cement, lime, or calcined gypsum; sand; and hair or some similar fibre.

LIME

Portland cement and lime have been discussed in other sections of this circular. In addition, the danger of "popping" caused by an inferior quality of lime should be considered. When lime is burned at too high a temperature, some of the calcium oxide will combine with the silica and iron in the stone to form compounds which slake very slowly. Compounds of the same nature may be produced if the lime is permitted to "burn" while slaking. These compounds take the form of small

granules which, when exposed to the air, will gradually absorb water and swell. If these granules occur in the finish coat or near the surface of the brown coat, they will eventually fall out of the plaster, leaving a little pinhole. Their presence can be prevented by making sure that the lime is perfectly hydrated before using. These compounds are generally removed from hydrated lime during the process of manufacture. It is advisable, however, to soak hydrate under water for two or three days before using, not only to insure the absence of partially hydrated material but also to improve the plasticity. To make a good paste from quicklime, the slaking must be conducted very carefully. Enough water is added to make a cream, which is passed through a screen of about 10 meshes per inch to take out any unburned limestone. The cream should then be allowed to settle for two or three weeks when the excess water may be drained off, and the paste is ready for use. To test a lime for the presence of materials which will cause popping, spread the paste in a thin layer ($\frac{1}{8}$ inch) on a glass plate. The particles which are apt to cause trouble are white to reflected light but opaque to transmitted light.

GYPSUM

Gypsum is a natural mineral, mined in many parts of the United States, consisting essentially of calcium sulphate crystallized with a definite amount of water. When this is heated to about 120°C (248°F), three-fourths of the water is driven off. The material remaining is ground to a fine powder and sold as calcined gypsum or plaster of Paris. This forms the basis of commercial "hard wall plaster." When mixed with water it combines with it and recrystallizes in the form of the original gypsum. This operation constitutes the setting of the plaster. Pure calcined gypsum

sets very rapidly. It is, therefore, necessary to add some material to retard the set, in order to allow time for the plaster to be applied. Hydrated lime is frequently used, because it improves the plasticity and also retards the set. A number of organic materials, like glue, dried blood, etc., are also used as retarders. On the other hand, set plaster (gypsum) is a very marked accelerator, so that one should be very careful to cleanse all tools after mixing each batch of plaster. It will be noted that only water is necessary for the setting of calcined gypsum and that this process can take place in the absence of air. But, unfortunately, the set gypsum is slightly soluble, so that it can not be used as a hydraulic cement. Probably the best test for the purity of calcined gypsum is its behavior when mixed with water. A ready-prepared plaster should set quite hard in from 30 minutes to one hour. Plaster of Paris will deteriorate on exposure to the air by taking up water and reverting to the original gypsum. However, the fact that it is a fine powder prevents the access of the air to the interior of the mass, so that not more than a thin layer on the surface of a pile will be spoiled. It is quite permissible to store calcined gypsum in the commercial package (paper bag), taking only ordinary precautions to keep it dry.

KEENE'S CEMENT

When calcined at over 400° C, gypsum loses all of its water. The material remaining is called anhydrite and has no power to set under ordinary circumstances. There are a number of compounds which may be added to anhydrite and which will cause it to set. The compound usually added is alum, the product so treated being known commercially as Keene's cement. This cement sets more slowly than calcined gypsum, but the ultimate product is the same—gypsum.

PROPORTIONS FOR COATS

Scratch Coat—The chief requisite for the scratch coat is strength. In exceptional cases it may be desirable to use a Portland-cement mortar, but this should be mixed with lime to improve its plasticity. For ordinary purposes, however, lime or gypsum plaster will be found sufficiently strong. It must be remembered that lime shrinks on setting, and that, therefore, a certain amount of sand is necessary to attain maximum strength. On the other hand, gypsum expands as it sets, so that in this case the sand is strictly an adulterant, causing a decrease of strength. When plastering on masonry, however, it is advisable to add enough sand so that the scratch coat will expand and contract to about the same extent as the masonry when subjected to changes of temperature or humidity. The proportions for scratch coat recommended by the manufacturers are:

	Parts
Hydrated lime	133
Sand	400
Hair	1
Or Calcined gypsum.....	100
Sand	267
Hair	1
Or Calcined gypsum.....	100
Sand	200

Brown Coat—For the brown coat strength is of minor importance, and it is, therefore, permissible to use a higher proportion of sand. This added quantity of sand has two advantages—it decreases the cost, which is very important in the brown coat, and the wall is better able to absorb sound, on account of its increased porosity. On the other hand, too much sand will weaken the plaster to such an extent that it may

not be able to withstand even ordinary impact and will also decrease the plasticity so as to make application difficult. The proportions recommended are 100 parts by weight of hydrated lime, 400 parts of sand, and $1\frac{1}{2}$ part of hair; or 100 parts of calcined gypsum to 300 parts of sand.

Finish Coat—For the finish coat it is customary to use a mixture of lime and calcined gypsum. The lime gives the plasticity which is so essential for a plane, smooth surface. The calcined gypsum makes the plaster set more quickly and gives it a harder surface. It may also tend to prevent cracking because of its expansion as it sets. There are two kinds of finish coats, differentiated by their appearance as "smooth" or "sand float." In the first the surface is troweled until it is as nearly smooth and plane as possible. In the second the bonding material on the surface is floated off, leaving the sand grains protruding; the surface is, therefore, plane but not smooth. The proportions of materials to be used in the finish coat depend upon the condition of the weather, the time of year, and the inclination of the plasterer. The following proportions are recommended as a guide but are not to be adhered to rigidly: For smooth finish, 1 part by volume of calcined gypsum to 3 parts of lime paste. For sand-float finish, 1 part by volume of calcined gypsum to $2\frac{1}{4}$ parts of lime paste and 3 parts of sand.

To cover 100 square yards of surface with three-coat plaster will require about 1600 pounds of calcined gypsum or 1200 pounds of hydrated lime, $13\frac{1}{4}$ cubic yards of sand, and 2 bushels of hair.

USUAL DEFECTS IN WALL PLASTER

It is generally difficult to determine the cause of any failure which may occur in wall plaster. Some of the more prevalent defects may be enumerated as

follows: 1. "Popping" is the term applied when small particles of the plaster pop out of the wall, leaving pinholes. This is due to insufficient preparation of the lime before application. 2. If the surface of the plaster can be rubbed off easily it is probable that the brown coat was not wet sufficiently before the finish coat was applied. This is also the usual cause of lack of bond between the coats, which may cause the finish coat to scale off in patches. 3. Lack of strength may be due to two causes—oversanding of the brown coat, which is indicated by a tendency of the sand to "run" when the finish coat is punctured; or undersanding, which is indicated by craze cracks in the finish coat. 4. A plaster which is frequently wet is apt to fall off eventually, especially if the scratch coat is calcined gypsum on metal lath. By far the greater number of defects, however, are due to the construction of the building and not to the plaster. The settling of foundations and the jarring of ceilings beyond their rigidity are the causes of almost all large cracks.

THE USE OF WALL BOARDS

Quite in keeping with the tendency to simplify home construction and reduce the amount of expensive labor is the increasing use of wall boards. Instead of having to nail up a support for plaster in the form of wood lath, metal lath, patented wood and mastic support, which is covered with the several coats of plaster, the wall boards are virtually complete walls which come in large sections and which are readily erected with a minimum of labor. They are merely nailed in place on the studs.

Wall boards may be divided into two general groups: first, those made from wood fibre compacted under great pressure into firm, strong, board-like panels; sec-

only, so-called plaster boards which are virtually plaster cast in panels for ready application.

Of the first kind—wood fibre boards—there are numerous brands and numerous stock sizes. The panels are moisture-proofed and sized in some brands to prevent warping and bulging, and to make painting easy and inexpensive. Beaver Board, which is typical of this kind of wall board, is made in panels 32 to 48 inches wide and in lengths of 6, 7, 8, 9, 10, 12, 14 and 16 feet. This kind of board may be used in new houses directly over the studs for walls and ceilings, forming good tight walls. In the old home it provides the quick, easy way permanently to restore cracked and shabby interiors. It speedily transforms attics or other waste spaces into livable, useful rooms. Beaver board and other similar wall boards may be painted with either flat or glossy oil paint. The decorative strips used over the panel intersections relieve the monotony of an unbroken expanse of wall and ceiling, and offer unlimited opportunities for artistic design.

Some brands of wood-fibre wall board come with markings to imitate tile. These may be painted with enamel to imitate tile in the finishing of a bathroom or kitchen.

Plaster board, on the other hand, does not have to be paneled with decorative strips to cover the joints for the reason that it is intended as a base for wall paper, paint, calcimine or other treatment. However, it can be paneled if desired, and many interior decorators prefer painted walls with panelling to the usual plain tinted wall or papered wall. Plaster board is virtually the equivalent of the usual plastered wall. It comes to the builder ready for use. The lathing is done, so to speak. The mixing of the plaster is done. The plastering itself is done. All that remains is to nail the board in ceiling-high sections directly to the supports.

The work of applying plaster boards is light and easy, clean and quick. There is no waiting for drying when the walls are finished. Rooms newly walled with plaster board are ready for immediate decoration.

One well-known and highly popular form of plaster board is Sheetrock. In this wall board, permanency has been attained by using gypsum rock as the basic material. Gypsum rock is also the basis for the wall plaster which has for many years been standard for the world's finest buildings. The rock is mined, refined, and toughened by a secret process. While still plastic, the pure gypsum is molded and compressed between two sheets of strong, protective covering made for the purpose. The units are of standard ceiling heights, strong, smooth, and uniform in size, with a thickness of $\frac{3}{8}$ inch. They are clean and easy to handle, and may be sawed or nailed like lumber. The reinforced edge, which is a patented and exclusive feature of sheetrock, takes the form of a tough, protective covering which is folded over the edges squarely, completely enveloping the gypsum. This provides an extra strong edge for nailing; and as all edges are true and of uniform thickness, tight, smooth joints are assured.

THE QUESTION OF INSULATION

We again mention in passing the importance of proper insulation against cold and heat for the walls of the house. The use of proper insulating material for filling the outside walls of residences and for use between rafters for the purpose of protection against heat in summer and cold in winter, is constantly growing. The owner should consult his builder and his architect with regard to proper insulation. At the same time, too, it is important to make sure that the building is properly sealed against the cold penetrating winds of the winter. Around door frames, around

window frames, at the bottom of the outside wall where it joins the foundation, at the top where it joins the roof, and in other places there is always a chance that the lumber members do not make a firm joint and that wind can get through. It does not take much wind to make the house most uncomfortable, and to run up the coal bill. The few dollars that may be saved in this connection by improper care in sealing the house will be spent many times over in the increased fuel bill brought about by a leaky house.

WINDOW FRAMES

The window and door frames of the home are a most important feature. They must be properly constructed and set in order to have the sash perform the work for which they are intended. The window frames and door frames may be made by the carpenter on the job or may be bought from a lumber mill, the latter procedure being more preferable in this day of quantity production and standardization. Frames made by hand on the job cannot compete with machinery-made frames either in accuracy or price. Then, too, the lumber mills now have a sufficient number of stock sizes to meet almost any need.

Of window frames in general use there are the check rail, the casement, and the stationary types. The check rail frames, which are the most familiar, are constructed of two sliding sash adjusted to go into the frame. The upper sash drops down and the lower sash can be raised up. All check rail frames with the exception of those furnished with barns, garages and summer cottages, are arranged with pockets and pulleys and weights to make the sash remain in any position in which they may be raised or lowered.

The casement type of window, instead of sliding up and down, swings open or closed like a door. Case-



Insulating a house with Balsam-Wool. Where the attic is not finished off, the Balsam-Wool can most economically be applied to the under side of the second-floor ceiling joists. Furring strips on each joist hold the Balsam-Wool firmly in place and provide nailing space for the ceiling lath.—(Courtesy Weyerhaeuser Forest Products.)

ment windows give a flexibility in ventilation control that is quite impossible in other designs. The whole window is used. Furthermore, casement windows lend themselves to any artistic treatment desired. Large panes, diamond leaded, stained glass or figured designs are adapted with ease and preserve the full beauty of the design.

One of the most convenient and what can be one of the most attractive rooms about the house is the sleeping porch when treated with out-swinging casements. Some people cannot afford to install a sleeping porch or again it may be impossible to adapt one to the design of the house. In such an event it becomes possible to obtain what amounts to a sleeping porch effect by means of casement windows.

The cost of an average double sized double hung window of 19 square feet area when complete is practically the same as that of a double casement window of the same area. A casement window of $14\frac{1}{2}$ square feet area gives 50 per cent more ventilation and slightly less light. This smaller sized casement can be had for considerably less cost.

The main consideration in casement windows is the question of hardware. Exposed as such hardware is to the elements, it should be made of solid brass or, if of steel, should be heavily plated to prevent rust.

The stationary window is, of course, a plain sash which, as its name implies, remains "put." Generally such a sash is arranged so that it can be taken out during the warm weather and replaced by a screen of a corresponding size. At any rate, it must be either in or out, since there is no in between measure as with other types of windows.

There are several points in connection with the fitting of window sash that merit the attention of the home-builder. Balky windows that stick, first on one side and then the other as one tries to open them, are

often the result of loose fitting and present a situation difficult to remedy. Properly fitted windows in a new house, especially if they are in place during the time the plastering is being done, may bind a little until after the house has dried out, and until the woodwork has had time to adjust itself to the atmospheric condition in the completed house. If after a few months' time they continue to bind, this condition can then be quickly eliminated, provided, of course, that the construction around the window frame is not the cause of the trouble.

Rattling windows are usually due to careless fitting of the window stops (the narrow strips which hold the lower sash in place). These stops should be held in place preferably by means of stop screws and washers, the holes in the stop being large enough to permit adjustment of the stop without entirely removing the screws.

The matter of making casement windows weather-proof is also deserving of careful attention. Any good builder who has had experience with casement windows can give the home-builder valuable advice on this subject.

In the matter of cellar windows, it is wise to make use of metal frames and windows, not only because of their sturdy construction and ability to withstand moisture, but also because they can be made with a smaller structure than wood and therefore give more light for the same sized opening. Metal coal chutes are also available for the well-built home.

THE MATTER OF INTERIOR TRIM

The pleasing appearance of interior woodwork and the satisfaction of having it "stay put" year in and year out depends so largely upon its treatment and the method of applying it as to merit consideration here.

Since the purpose of trim is to beautify, it should be well joined and pleasingly and appropriately finished. Satisfactory interior finish, like good plaster work, starts at the foundation footings. Uneven settling, due to those structural defects now familiar to the reader, is the greatest cause of unsightly openings and cracks in woodwork. A good job, however, is also dependent on the care the material receives before applying, and the workmanship in placing it.

Interior trim (including the lumber used for base boards, picture and cornice moldings, door and window casings, etc.) is seasoned and kiln dried before it leaves the factory and should be protected from water and moisture until it is in place. It should not be allowed to stand out in the open after being delivered on the job nor should it be brought into the house until after the plaster has dried. If it is allowed to absorb moisture, it will swell and warp and if nailed when wet unsightly cracks will develop as it dries out.

The trim is ordinarily nailed to the framing members. In places where there are no framing members to take the nails, nailing blocks of two-inch lumber are set into the walls before they are plastered to provide nailing surface for the trim. All trim should be well nailed.

It is especially necessary to have a tight joint between the window stool and the sill in order to keep rain and cold from entering. To effect this tight joint, the under side of the stool and the top of the sill, where they meet, should have a coating of good paint.

DOORS AND THEIR CARE

The care of doors before they are hung is just as important as the care of interior trim and the same precautions apply to both. Furthermore, if troublesome doors would be avoided, the top and the bottom

edge of each door should receive two coats of paint as the doors are hung. This seals the pores of the wood and prevents, to a large extent, the absorption of moisture that otherwise would cause the door to swell and bind with a very rainy or wet spell.

Veneered doors are not adapted to places where they will be entirely exposed to the weather. Moisture from rain and snow will, in time, loosen the veneer and a new door will be necessary. For outside doors, therefore, only solid, paneled doors are recommended.

Hardwood doors are generally shipped "in the white" (unfinished) and moisture must not be allowed to penetrate them. As quickly as possible after receiving the doors they should be finished with at least one coat of filler, and immediately after fitting them they should be painted or shellaced top and bottom.

THE QUESTION OF FLOORS

No house can lay claim to being well built unless it has a sub-floor and a finish floor. In many of the present-day houses it will be found that the builder has skimmed by laying a hardwood or even soft-wood single floor. Not only does such a floor fail to possess the rigidity and strength of a double floor, but it also permits the cold and dampness and ash dust to come up from the basement.

As has already been pointed out elsewhere, it is best to lay sub-floors diagonally. At any rate, the finish floor should be laid at an angle to the sub-floor and preferably at right angles to the joists. This reduces shrinkage and its resultant evils to a minimum. Bulges and cracks in floors also result from poor nailing and failure to provide for floor expansion.

The best maple, beech and birch floors cost very little more than the better classes of soft-wood floors. The slight difference in cost is more than offset by the

great difference in wearing and appearance values. Because of their fine characteristics, maple, beech, and birch are popular flooring materials for the home. Beech and birch possess warm and pleasing color tones. Maple is not a characterless wood as some have assumed it to be. When varnished or waxed, maple has a beautiful golden-yellowish color which in time deepens to reddish gold.

There are three grades of maple, beech and birch flooring, namely, Clear, No. 1, and Factory. Clear is the finest grade and should be used where appearance is a paramount consideration. No 1 is as serviceable and as desirable as Clear when there is no objection to the appearance. The Factory, or third grade, is intended for use in factories, creameries, granaries, mills, warehouses, workshops and so on, where a low-priced floor is wanted for wear rather than for appearance.

Maple, beech, and birch matched stock comes in the standard thickness of 13/16 inch, with faces of 1½, 2, 2¼ and 3¼ inches. It is also available in special thicknesses of 1 1-16, 1 5-16, 1 11-16, with faces of 2 inches, 2¼ and 3¼ inches, and ¾, ½, and ⅝ inch, with faces of 1½, 2 and 2¼ inches.

To ascertain the number of feet of matched flooring required to cover a given area, find the number of square feet of floor space to be covered and add thereto the following percentages:

Matched Stock	5/8" and 13-16" thick	3/8 and 1/2 thick
1½" face flooring	50 per cent	33⅓ per cent
2" face flooring	37½ per cent	25 per cent
2¼" face flooring	33⅓ per cent	22½ per cent
3¼" face flooring	24 per cent	not made.

The 13-16 inch thickness of maple, beech and birch flooring is most commonly used. It can be laid di-

rectly on the joists, or on strips embedded in cement when the latter is used for fireproofing, but is more frequently laid on a subfloor. For ordinary purposes a diagonal subfloor made of softwood boards, surfaced one or two sides, is sufficient. This may be used for the work floor during the progress of building and the hardwood floor should not be laid until the building is dry.

The 1 1-16 inch thick hardwood flooring is sometimes preferred when the floor is to be subjected to extraordinary strain, but the 13-16 inch is suitable for general purposes. The $\frac{1}{2}$ -inch thickness is suitable for apartment buildings, churches, clubs, offices and similar buildings. Under ordinary foot wear it is as serviceable as the 13-16 inch. If the subfloor is uneven, the $\frac{1}{2}$ -inch flooring will produce more satisfactory results than the $\frac{3}{8}$ -inch thick.

The $\frac{3}{8}$ -inch is the most popular thickness under 13-16 inch. It is superior to parquetry because the sides and ends of the flooring are matched so that it can be laid with the nails entirely concealed, and they cannot work out.

OAK FLOORING

There are two kinds of oak principally used for flooring. There is small choice between them as far as merit goes and usually no difference in price. They are white oak and red oak. The chief difference is that the white oak is somewhat lighter in color and of not quite so "warm" a tint as red oak. The personal preference is the best guide here, and most people would quite as soon have the one as the other.

Oak flooring is made in two standard thicknesses and several widths. For new floors in new buildings it is made 13-16 inch thick. For laying over old floors it is made but $\frac{3}{8}$ inch thick, for the reason that over

an old floor that is strong enough already, what is needed is the surface, not the strength, and it would be a needless expense to make it full thickness. Either kind will last so long that, practically, one may say that it will never wear out.

The widths made in $\frac{3}{8}$ inch oak for laying over old floors are $1\frac{1}{2}$ inches and 2 inches. In the 13-16 inch flooring, used in new buildings, the widths are $1\frac{1}{2}$ inches, 2 inches and $2\frac{1}{4}$ inches. The use of various widths is a matter of personal preference and price.

The standard shape of oak flooring used by the leading manufacturers of oak flooring is the result of long experience and careful scientific study. It is interesting to see how such a simple thing can mean so much. By looking at a piece of oak flooring, it will be noted that each piece of flooring is tongued or grooved on both sides and both ends. This is, of course, to hold the flooring close and level and, simple though it appears, the exact form of tongue and groove to go together easiest and hold hardest has been a matter for much experiment and study.

Another ingenious feature is that all oak flooring is made just the least bit narrower at the back than at the face. The result of this is that when tightly nailed together the backs cannot hold the faces apart and this is why no joints or "cracks" can show in a well-laid oak floor.

The reason why no nail holes show in an oak floor is that the strips are so designed that the nails are driven at an angle through the tongue. The top of each new strip thus covers up the heads of the nails in the strip nailed last before it. This is called "blind nailing."

There are seven grades of oak flooring, three of quarter-sawed and four of plain sawed. Quarter-sawed oak has a peculiar figure or pattern on its surface with which most of us are familiar. Plain sawed oak is

made without regard for figure but is for most purposes quite as desirable as quartered.

The uses of the various grades of oak flooring are as follows:

Clear, quarter-sawed: Fine residences, hotels, apartment houses, churches, club houses, etc.

Sap clear, quarter-sawed: and *Select, quarter-sawed*: These grades are very satisfactory to use in place of Clear, quarter-sawed for the sake of lower price and especially if a darker finish is desired.

Clear, plain-sawed: Fine residences, hotels, apartment houses, churches, club houses, etc.

Select, plain-sawed: A lower-priced floor for the above uses which is also widely used in schools, office buildings and stores.

No 1 Common: Low-priced houses, tenements, etc., high-grade factories and manufacturing buildings.

No. 2 Common: Used wherever a durable floor and a low price are the principal requirements, as in warehouses, factories, tenement houses, etc.

LAYING THE FINISH FLOORING

With the sub-floor to work upon, the finish floor is ready to be laid. If the top floor is to be laid directly on the sub-floor—or with only deadening felt between—nail all twisted, cupped, or broken members of the sub-floor securely in place, so that a substantial and even surface will be secured.

In some buildings the hardwood floor is laid on furring strips. If that method is called for, the face of the strips must be lined up accurately.

Hardwood should not be delivered until the building, including the plaster, is thoroughly dry. Occasionally the flooring is much dryer than the building and absorbs moisture, which causes the strips to swell before they are laid. When heat is applied the surplus mois-

ture is driven off, the strips shrink, and the cracks appear.

Dry flooring laid in a damp building will swell and cause "cupping" or buckling. The only remedy for a cupped floor is to scrape it to a true surface. It is almost impossible to drive a buckled floor back into place, the nails tending to support it into the position into which it was forced. The alternative is to take up the flooring and relay it. So it is better to wait until the building is dry and have a perfect floor. The proper time to lay the finish floor is when the building, including the plaster, is thoroughly dry and right after the interior trim has been installed and finished.

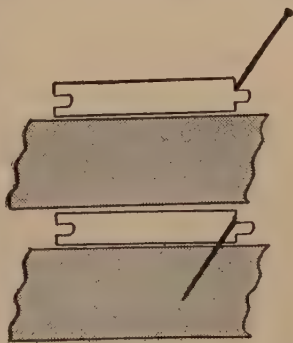
If work must be started before that time the floor should be primed as soon as possible after it is put down. When the primer is hard, cover the floor with sized building paper. The primer will keep out the dirt and also tend to prevent the absorption of moisture. Dipping the flooring strips in raw linseed oil, heated as nearly as possible to the boiling point, will safeguard them effectively from moisture. Flooring so treated may subsequently be waxed or varnished. Dipped flooring has been used with excellent results in reflooring buildings in use. Three or four days should be allowed to ensure thorough absorption of the oil.

If the trip is in place, the first course of strips should be lined up flush with the surface of the mop-board, which must not extend below the surface of the top floor. Do not, under any circumstances, drive the flooring tight against studding or walls. Nail the first course directly through that portion to be covered with the quarter-round base shoe.

It is important to plan in advance the situation where the floor continues into other rooms. Thresholds are little used now and the courses of flooring strips should run true from one end to the other, re-

ardless of the number of rooms through which they pass. Ordinarily, the floor in the center of the room is covered with rugs. Select the choice strips for the sides and ends which form the exposed portions and which are always in view. Use a block to drive the strips together or to drive them enewise. Do not batter the tongue, injure the matching, or mar the surface.

The flooring, in the case of the usual hardwood flooring, is furnished in mixed lengths, which facilitates rapid laying, as it enables the workmen to combine the lengths economically and avoids unnecessary waste in cutting. The shorter lengths are particularly handy in this respect as they fit in readily and can be driven together quickly with a tap of the hammer. When necessary to trim a piece of flooring to finish out a course, it is better to use a piece of sufficient length so that the part trimmed off may be used for starting a new course. This is an economy which will suggest itself to competent floor-layers. Do not start to nail until the strip is in place. It is unwise to rely wholly or largely on the nails to draw the strips together. Damage to tongue makes it difficult to enter the groove of the next piece.



Method of nailing the finish flooring in place. Note how the nail in the first sketch has been driven down as shown in the second sketch.

Floors, after having been laid, must be scraped and finished. The various boards are not necessarily all of the same height, hence the surface must be scraped by hand or by machine so as to make the floor of one

uniform height. Today there are electrically-operated scraping machines available which materially simplify this feature of the work of finishing floors. In our chapter on painting, we go into details regarding the finishing hardwood floors, as well as soft-wood floors.

Of late there has been placed on the market a hardwood floor which comes in finished strips. Owing to the shape of these strips, they can be assembled together with their tongue and groove devices and nailed in place. The strips are already finished so that the floor is finished the moment it is laid. Obviously, this saves considerable time and labor, although such flooring has a considerably wider line or "crack" between the "boards" than the usual hardwood floor.

NON-WOOD FLOORS AND LINOLEUM

Aside from wood floors, there are various other kinds of floors which find applications in the better kind of dwelling. Thus for the kitchen, laundry, vestibule, sun parlor and bathroom, if desired, there are the composition floors. These consist of a combination of chemicals and fibres which produce a durable, sanitary, resilient, fireproof floor covering that is applied about $\frac{3}{8}$ of an inch over any reasonably firm foundation, such as old or new wood floors, concrete, brick, or hollow tile. Laid in plastic state, such a floor becomes one solid sheet, practically a seamless tile. It presents a smooth, continuous surface, free from all cracks, crevices or joints. This fact renders it sanitary and easily cleaned, as there is no place for dust, dirt, moisture or grease to accumulate. Such composition flooring is obtainable in various colors to suit the taste. The material for this flooring is shipped in powder and liquid form, as both are necessary to produce the finished floor. The two materials are mixed together on the job and applied in a plastic

state to a thickness of $\frac{3}{8}$ inch over any reasonably firm foundation.

Then there are tile floors. The advantages of tile floors for the bathroom hardly need be pointed out. Good tile, properly applied on a foundation of sound framing, is essential to satisfactory tile work. (See page 365.)

Tile is also employed in kitchens, in which case the individual tiles are of fairly large size. They are laid in much the same manner as already described.

One of the most convenient forms of floor covering is linoleum, which is a preparation of oxidized linseed oil and ground cork with a tough burlap backing. Linoleum is not to be confused with the cheaper heavy oil cloth floor coverings which do not begin to have the wearing properties of the genuine product. Linoleum comes in rolls which are cut and laid to cover the entire floor, in attractive rugs, and in small pieces of tiles, known as linotiles. In laying the usual linoleum the practice heretofore has been to nail it down. Because of its simplicity and expediency, this practice has continued in use, although, truth to tell, it is quite inefficient. The linoleum not only stretches in due course, causing the joints to bulge up and the linoleum to break and wear at the joints, but water gets down through the cracks and rots the underside of the linoleum.

The best method now in use is to cement the linoleum. It is carefully cut to fit and is then laid over a special felt and securely cemented in place, without nails. Such a job lasts for many years. If linoleum is to be used in one's own home, it is best to have the linoleum cemented so that it will stay in place and last for many years to come.

A recent innovation in the form of linoleum is the so-called linotile. This is nothing more than small pieces of tiles of linoleum, which are assembled and

held in place with cement, much after the fashion of cemented linoleum. Because of the small size of the individual pieces, as well as the variety of shapes and colors, it is possible to make a most attractive pattern of this material. It is soft under foot, and many prefer it to the hard, cold tile.

HARDWARE FOR THE HOME

One of the little things of the home which, in the aggregate, becomes an important item, is the hardware. No where else is there the temptation to save as in the item of hardware. Only too often the builder will skimp in the matter of locks, window hardware, hinges, and so on. He may give preference to a cheaper article, which in first appearance may be as good as the more expensive article. The builder should always beware of the many imitations of brass and bronze. A thin coating or plating is frequently used to cover a steel base. This scant protective coating over quick-rusting steel is only temporary at best. Ordinary wear and exposure to the atmosphere soon expose the base metal. And frequently in as short a time as six months or a year the hardware or fixture made to imitate brass or bronze is a mass of rust and must be replaced. Hence it is best to spend a little more for the first cost in order to ensure lasting satisfaction.

CHAPTER XIII.

PAINTS AND PAINTING ABOUT THE HOME

PAINTS and varnishes are used to protect and decorate surfaces of wood, metal, and other materials. They are applied in thin coatings, which harden after application. Only too often paints and varnishes are looked upon as purely decorative agents, whereas they should be considered first and foremost because of their protective properties, and secondly for their artistic possibilities.

A paint is essentially a mixture of solid and liquid, which gives an opaque coating; a varnish, on the other hand, is essentially a liquid which gives a transparent coating. The solid matter in paint is the pigment or coloring matter. The liquid (linseed oil, for example) is called the vehicle. While varnish is used in very much the same manner as paint, it could not properly be classified as paint, because it does not contain any solid particles of pigment. On the other hand, white wash, which is not ordinarily called a paint (largely because of its cheapness) complies with the definition.

THE DRYING OF PAINT AND VARNISH

Water paints, such as whitewash, and spirit varnishes, such as shellac in alcohol, dry by simple evap-

oration of a volatile liquid, this being water in the case of white wash and alcohol in the case of shellac.

The drying of oil paints and varnishes, however, is quite different, and in order to understand this attention must be drawn to certain peculiarities of the so-called drying oils. Suppose four plates of glass are coated, one with a thin film of water, another with gasoline, another with a heavy mineral oil, and another with linseed oil, and all four plates are exposed to the air for several days. The water and gasoline will evaporate and leave the plates dry and in practically the condition in which they were before applying the liquid. The plate covered with heavy mineral oil will be found to be greasy, while the plate covered with the linseed oil will also have a coating on it, but this coat will first become tacky and finally set to a hard varnish-like film. If this experiment is tried with other vegetable oils, it will be found that some of them—olive oil, for example—behave very much like heavy mineral oils; that is, there is only a very slight tendency toward the formation of a varnish-like coating. Other oils, such as corn and soya bean, will behave in a manner similar to linseed oil; that is, there will be the formation of a more or less tacky mass, with perhaps the final formation of a varnish-like surface. Oils which behave like linseed oil are called drying oils. It will be seen from this illustration, however, that the term "drying" as applied to such an oil is not similar to the drying which takes place on the exposure to dry air of a material wet with water. The drying of a substance wet with water is really the removal of the water by evaporation. The drying of a drying oil is a change taking place in the liquid. This change is accomplished by an absorption of oxygen and is hastened by dry weather and by sunlight. It is also accelerated by the presence of certain substances which will be discussed later.

INGREDIENTS OF PAINTS

The materials used in making paints are too numerous to mention in a publication of this character, and brief mention only can be made of some of the more important materials so used by manufacturers.



Close-up view of the white trim of a frame house, showing how the paint has become scaly through age. In this condition it no longer protects the wood against moisture.—(Photo. by the author.)

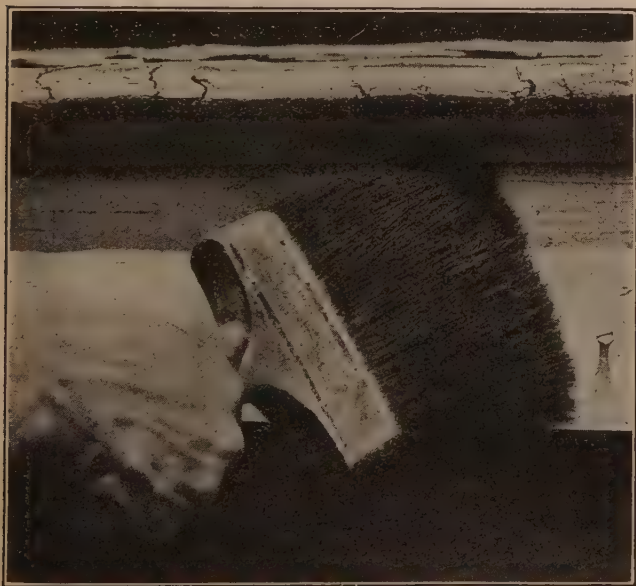
Linseed oil, which is the oil obtained from the seed of the flax plant, is the most important of the drying oils. This oil enters into commerce as raw linseed oil and boiled linseed oil. The raw oil varies in color

from pale straw to dark amber and has a mild characteristic odor. It frequently contains considerable sediment or cloudy or mucilagenous matter, which is generally objectionable, as perfectly clear oil is preferred by all painters. Good raw linseed oil when spread in thin films and exposed to the air and light will generally dry to a fairly hard film free from tackiness in from two to six days. Refined linseed oil is oil that has been treated by a variety of methods to remove the mucilagenous matter and at the same time some of the color. In properties it differs little if any from good raw oil.

The term "boiled" as applied to linseed oil is strictly a misnomer, since linseed oil does not boil as water does but when heated to a sufficiently high temperature undergoes decomposition. It was, however, long ago observed that if linseed oil is heated to a temperature somewhat below its decomposition point with oxides of lead and manganese some of the metals go into solution and the oil dries more rapidly than raw oil. This method of heating all of the oil with metallic oxides is practically obsolete. In modern practice the manufacturer of boiled oil first makes a very concentrated boiled oil; that is, one containing a comparatively large percentage of dissolved lead and manganese, 15 to 20 times as much as is required in boiled oil. This material, known as "crusher's drier," is mixed with raw linseed oil in the proportion of about 1 to 16 and the mixture heated to incorporate completely the "crusher's drier" with the oil. In some cases the "crusher's drier" is made from rosin and oxides of lead and manganese instead of linseed oil and the oxides. Boiled oil made in this way is called "resinate boiled oil," while that in which no rosin is used is called "linoleate boiled oil." If properly made and no excessive amount of rosin is used, a "resinate boiled oil" may be as good as a "linoleate boiled oil,"

but the fact that much boiled oil contains an excessive amount of rosin and is, consequently, of inferior quality has caused "resinate boiled oil" to be looked upon with suspicion, according to the Bureau of Standards, to whom the author is indebted for most of the data in this chapter.

There is another type of boiled oil, derisively called "bung-hole oil," which is simply raw oil to which a drier, usually a turpentine or light mineral-oil solution



Convenient way of holding a large brush. A brush of this size enables the painter to cover considerable ground on outside work, although it is somewhat tiresome on the wrist.—(Photo. by the author.)

of lead and manganese resinate or linoleate, has been added without heating.

The advantage of boiled oil over raw oil is that it dries more rapidly. It must be remembered, however, that in most paints where raw oil is used a certain amount of "drier" is added which hastens the drying. There is little if any material difference between results obtained with boiled oil and with raw oil with the proper addition of drier.

DRIERS—WHAT THEY ARE AND WHAT THEY DO

Certain metals, especially lead and manganese, when in solution in drying oils cause the drying to take place more rapidly. While certain pigments, such as red lead, act as driers and some driers are in paste form, most so-called driers are in liquid form. These are known as "driers," "oil driers," "Japan driers," or simply "Japans." They consist either of solutions of lead or manganese salts, of acids of linseed oil or of resins, or of mixtures of such salts dissolved in volatile solvents, such as turpentine or light petroleum oil. The amount of lead and manganese present is relatively small. The ash of liquid drier, which usually consists of the oxides of lead and manganese with sometimes some lime, varies from about 0.5 per cent to 15 per cent, usually from 5 to 8 per cent. Strictly speaking, an "oil drier" should contain no varnish resin, and a "Japan drier" should contain such resin, but this distinction is not adhered to in the trade, and many manufacturers use the terms so loosely that the name can not be taken as any indication as to whether the material contains resin or not.

VOLATILE THINNERS

Turpentine, which is the volatile liquid made by distilling the resin of pine trees, is the most important volatile thinner used. This has excellent solvent, evap-

orating, and flattening properties and is preferred for general paint and varnish operations. It is, however, expensive, and in many cases the cheaper volatile liquids, such as light mineral oil, variously known as "benzine," "naphtha," "petroleum spirit," "turpentine substitute," etc., may be successfully used. "Coal-tar naphtha" or crude benzol is also so used in certain cases. Alcohol, carbon bisulphide, and numerous other volatile liquids also enter into some paint preparations.

In addition to drying oils and volatile thinners, varnishes are important liquid constituents of certain paints.

PIGMENTS

The number of substances used as paint pigments is so great that no attempt can be made in a publication of this character even to mention more than those in common use. In general, a paint pigment should consist of very finely divided particles; it should possess hiding power, that is, in the vehicle used; it should form as nearly as possible an opaque coating; and it should have no injurious action on the vehicle or the surface on which the paint is to be applied. It should not have an excessive tendency to settle out from suspension in the vehicle. There are a great many colored substances which have good hiding power; but most white substances which might otherwise be suitable for paint pigments give, with oil mixtures, a coat which is quite transparent. There are, practically, only four substances which can be used as white pigments of good hiding power. These are white lead or basic carbonate white lead, sublimed lead or basic sulphate white lead, zinc white or zinc oxide and lithopone (a material composed of zinc sulphide and barium sulphate). (The rather indefinite mixtures of lead sulphate and zinc oxide obtained from zinc lead ore and known as "leaded zinc," or "zinc lead," etc., may be

considered as mixtures of sublimed lead and zinc white.) White "extending" pigments, such as barytes, whiting, silica, asbestine, etc., when used alone with oil do not make opaque films, but are sometimes used in connection with the true-white pigments mentioned above and are also used with numerous colored pigments which have good hiding properties.

Among red pigments may be mentioned red lead and various iron-oxide pigments. Yellows include chrome yellow (lead chromate) and ocher, which is an earthy pigment containing hydrated oxide of iron. The principal blues are Prussian blue and ultra-marine. Greens are made by mixing yellow and blue. Blacks are various carbon pigments, such as lampblack, which is soot; graphite, a mineral substance; and bone charcoal, known as ivory black, drop black, or bone black. Various artificial coloring matters in the form of "lakes"—that is, the artificial (coal-tar) colors thrown down on a base such as white or red lead, barium sulphate, etc.—are used. The most brilliant reds, for example, belong to this class.

VARNISHES

Varnishes may be classed as spirit varnishes and oil varnishes. Spirit varnishes are simply solutions or partial solutions of resinous substances in volatile solvents. Shellac varnish is a solution of gum shellac in alcohol. Damar varnish is a solution of damar resin in turpentine. In this class may be included the collodion or zapon varnishes, which are solutions of nitrated cellulose in solvents such as amylacetate and alcohol-ether mixtures. Oil varnishes are not made by simple solution of varnish resins in solvents. The important varnish resins, of which there are quite a number, as kauri, Manila copal, Zanzibar copal, etc., are not soluble in their original condition. The varnish

maker can, however, by heating and addition of drying oils and drying metals, produce a substance which can be thinned with some volatile thinner to produce the well-known oil varnishes. Oil varnishes differ widely in properties, and there is no easy way of determining their quality. In general, common rosin as a constituent in considerable quantity causes the varnish to be of inferior quality, giving a film which turns white on exposure to water and which does not last well. Some excellent varnishes, however, are made with rosin and China wood oil. Oil varnishes generally contain from 40 to 60 per cent of volatile thinner (turpentine or light mineral oil). "Long-oil varnishes"—that is, those which contain a large amount of drying oil (say, 40 to 60 per cent drying oil and from 5 to 20 per cent resins)—yield coats which while not so hard are more resistant to weather than those produced by "short-oil varnishes"; that is, those which contain a relatively large amount of varnish resins (say, 20 to 35 per cent resin and 25 to 40 per cent drying oil). A spar varnish may be taken as an example of a long-oil varnish, a rubbing varnish as an example of a short-oil varnish.

PAINTS

If an attempt is made to prepare an oil paint by mixing the dry pigment and vehicle in a bucket by hand, it will generally be found very difficult to obtain a sufficiently uniform mixture. The pigments, may, however, be ground in a mill to a uniform paste with a small amount of oil, and this paste can be easily mixed with more oil, etc., to form a satisfactory paint. On this account the painter who mixes his own paint generally purchases his pigments in paste rather than in dry form. Some pigments require more oil than others to make a satisfactory paste. White-lead paste, for example, contains about 8 to 10 per cent of linseed

oil. White-zinc paste contains about 17 per cent of linseed oil. The other white pigments are not commonly sold in the form of paste, but the various tinting pigments, such as chrome yellow, lampblack, drop black, ocher, etc., are commonly sold as pastes, the proportions of pigment and oil varying greatly with the different pigments. Putty is of the same general nature as paste paints. Ordinarily, putty is whiting ground to a paste with linseed oil. It is important that the oil should be linseed oil, and the not infrequent addition of mineral oil can only result in the production of a very inferior article. The vehicle for best-quality outside paint (last coat) would generally consist of 90 to 95 per cent of raw linseed oil and from 10 to 5 per cent of Japan drier. The following may be taken as representative compositions of such white paints:

To make about 1 gallon of white-lead paint (weighing about 21 pounds to the gallon), mix together 14 pounds of dry white lead, 7 pounds of raw linseed oil, and $\frac{1}{4}$ pound of Japan drier; or 15 pounds of white-lead paste, 6 pounds of raw linseed oil, and $\frac{1}{4}$ pound of Japan drier.

FINISHED PAINTS AND PAINTING

Since the composition of a paint must be varied in order to secure the best results, depending upon the character of the surface to which it is to be applied and the nature of the exposure, it seems best to consider the paint and method of application together. From what has been said in speaking of pigments it is apparent that for white or for very light-colored or tinted oil paint one or more of the expensive lead or zinc pigments must be used in order to get a paint which will have satisfactory hiding properties. Of the white pigments which furnish sufficiently opaque films

with oil, lithopone has the disadvantage of producing a paint which does not wear well for outside exposure, although it is much used for interiors. We can, therefore, consider that we must use one or more of the pigments white lead, sublimed lead, or zinc white for white or light-colored outside oil paints. White lead is commonly handled by dealers in painters' supplies in the form of paste. Zinc white is frequently so handled, but it is not common to find the other white pigments handled in paste form. Paints mixed by the painter, therefore, are usually white-lead paints or white-lead and white-zinc paints. (White zinc is very seldom used alone to make an oil-paint.) "White lead and linseed oil" has been most extensively used in the past, and many experts still prefer it for general outside use. White lead, however, has a tendency to chalk; zinc white, on the other hand, has a tendency to crack. A mixture of the two pigments produces a coat which appears on the whole more satisfactory than that from either alone, the zinc decreasing the tendency to chalk and the lead decreasing the tendency to crack. The addition of small amounts of the so-called "inert" white pigments, such as silica, barium sulphate, etc., seems to produce a still more satisfactory paint.

In all painting attention must be given to the character of the surface on which the paint is to be applied. In all cases the surface should be clean and dry. New wood often is very difficult to paint. The resins in such wood as yellow pine and cypress tend to destroy any paint that is laid over them. When possible, it is best to allow a new house to stand unpainted for at least six months or even a year after the woodwork has been completed. By this exposure to the weather the resins are brought to the surface and are either washed away or hardened, and the resulting wood surface is in much better condition for painting than a new structure. This delay is objectionable, however,

and painters adopt several methods of treating new wood. Coating all knots and other places where rosin appears with shellac varnish is a common precaution. A plan which is not so universally used but which appears to be quite satisfactory is to add a small amount of benzol (coal-tar naphtha) to the paint used as priming or first coat. Benzol is an excellent solvent for the wood resins, and its addition tends to cause the paint to penetrate the pores of the wood. The proportions of ingredients in a paint may be varied to a considerable extent. The following are only illustrations but are believed to represent good practice:

WHITE LEAD MIXED ON THE JOB, FOR OUTSIDE EXPOSURE

It is most convenient to make a base paint which is somewhat too thick for spreading and from this prepare the paint for the successive coats. Such a base can be made by mixing 15.5 pounds of white-lead paste, 3 pints of raw linseed oil, and 5 ounces of turpentine Japan drier. To the base add, according to the coat and character of wood, as follows:

Additions to above base	First coat		Second coats, all woods	Thrd (last) coats, all woods
	Basswood	Yellow pine or Cypress		
Raw linseed oil.....pints..	$\frac{1}{4}$	$\frac{1}{4}$	...	$1\frac{1}{2}$
Turpentinepints..	$1\frac{2}{3}$	$1\frac{2}{3}$	1	...
Japan drier.....ounce..	...	1	...	...
Benzolpint..	...	$\frac{2}{3}$	...	...

The paints for the above coats will contain from 66 to 72 per cent pigment and will weigh from $17\frac{1}{2}$ to 20 pounds per gallon.

READY-MIXED PAINT

A typical example of a ready-mixed paint has the following composition:

	Per cent
White lead	27
White zinc	33
Linseed oil	35
Turpentine Japan drier	5

This paint weighs about $15\frac{3}{4}$ pounds to the gallon.

An example of a ready-mixed outside white paint containing some extending (inert) pigment has the following composition:

	Per cent
White lead	24
White zinc	31
Silica and silicates	7
Linseed oil	35
Turpentine Japan drier	3

This paint weighs about $15\frac{1}{2}$ pounds to the gallon.

In the practical application of the above ready-mixed paints by a competent painter the following additions were made:

Additions to 1 gallon	First coat		Second coat, all woods ^a Pint
	Basswood Pint	Yellow pine or cypress Pint	
Raw linseed oil.....	1/6	1/6	...
Turpentine	1/2	1/2	1/3
Benzol	...	2/3	...

^a Third coat applied without additions

It is evident from what has been said above that there is considerable variation in composition of white

paints of good quality; but in general it may be stated that for repainting a frame house the last coat should contain from 60 to 75 per cent of pigment and from 25 to 40 per cent of vehicle. The pigment should contain not more than 15 per cent of extending (inert) material, such as barium sulphate, silica, asbestine, etc., and not less than 85 per cent of approximately equal parts of white lead and white zinc. The vehicle should consist of raw linseed oil with a small amount (not over 10 per cent) of Japan drier. If more than one coat is required, the under coats should be of the same nature as the last coat, except that the 25 to 40 per cent of vehicle should consist of about 75 to 80 per cent of raw linseed oil, about 10 to 15 per cent of turpentine, and not over 10 per cent of Japan drier. The addition of turpentine is to assure bonding with the old paint and to produce a better surface upon which to apply the final coat.

For light tints small amounts, seldom as much as 10 per cent and frequently less than 1 per cent, of coloring matter are added to white paints.

For dark paints the vehicle portion should be of the same general nature as in whites. For dark shades of red or brown there is probably nothing more satisfactory or cheaper than the oxide-of-iron pigments. These vary much in color, giving both brown and dull reds. They also vary in fineness and specific gravity, but, in general, paints of this nature will contain from 40 to 60 per cent of pigment. A dark green will usually contain from 60 to 70 per cent of pigment, which generally consists of 20 per cent of chrome green (lead chromate and Prussian blue) and 80 per cent of barium sulphate.

Painting should be done in clear, moderately warm weather. Great care should be taken that each coat is thoroughly dry before applying the next coat. It is

a good plan to observe when the paint appears to be thoroughly dry and then wait at least 48 hours longer before applying another coat. All nail holes, cracks, etc., should be carefully filled with putty after the priming coat. If putty is applied to unpainted wood it will not stick. The surface on which another coat of paint is to be applied should not be glossy. The proper "flat" surface is generally secured by having some volatile thinner in the under coats; but should such a coat have any gloss it should be lightly sand-papered or rubbed with steel wool to remove all gloss. For inside work it is often preferred to have the final coat "flat." Inside paints, therefore, generally contain somewhat more volatile thinner than outside paints. Also, since drying is not so rapid indoors, more drier is frequently added.

WALL PAINTS

Within the last few years the use for interior walls of paint which can be washed has become very general, and quite cheap paints which answer very well for such use, both on plastered walls and interior wood, are now commonly sold. These usually contain about 65 per cent of pigment, generally lithopone, about 20 per cent of turpentine substitute (light mineral oil), and about 15 per cent of nonvolatile vehicle. The important constituent seems to be the nonvolatile vehicle. It is important to have the paint contain enough thinner to allow some addition of oil for first coats and still be of proper brush consistency without any danger of drying with a gloss. The property of China wood oil of "bodying" (or thickening) to a great extent makes it a valuable constituent, hence the nonvolatile vehicle in such paints is usually a rosin China wood oil varnish.

ENAMEL PAINTS

Enamel paints are made with a varnish vehicle. In other respects they differ little from oil paints. An example of such a paint is zinc white in damar varnish.

Red lead is only used for protecting iron and steel. Experience and tests indicate that from a practical standpoint this material is certainly one of the best if not actually the best for this purpose. Contrary to usual practice with other paints, red-lead paint is usually mixed on the job from dry red lead, linseed oil, and sometimes a little turpentine and Japan drier. Red lead consists of oxides of lead, and ordinarily when mixed with linseed oil will in the course of a few days cake to a hard mass in the can. On this account it has been found necessary not to mix the pigment and vehicle until the time of application of the paint. (Within the last few years red lead remarkably free from the lower oxides of lead has been produced, and it has been found that this material can be successfully kept in paste form. This is not, however, representative of most red lead.)

A very satisfactory formula for red-lead paint is:

Dry red lead (pounds).....	20
Raw linseed oil (pints)	5
Japan drier (pint).....	$\frac{1}{2}$
Turpentine (pint).....	$\frac{1}{2}$

This will make about 1 gallon of paint, which will weigh about 25 pounds.

STAINS

Shingle stains are similar to paints but are made much thinner and usually contain coal-tar cresote as part of the vehicle, thus assisting in preserving the

wood. The pigment should be of the best quality, have the maximum color strength, and should be exceedingly finely ground in oil. The amount of pigment seldom exceeds from $1\frac{1}{2}$ to 2 pounds to the gallon of stain. The vehicle is generally about 40 per cent creosote oil, 40 per cent heavy benzene, and 20 per cent benzene Japan drier. It is best to dip the shingles in the stain before putting on the roof, but shingle stains are frequently applied with a brush. A shingle stain is intended primarily to preserve the wood, but on account of appearance the shingles should be uniformly colored, hence the pigments used should possess great color strength and be very opaque.

While similar to shingle stains in that they are exceedingly thin paints, wood stains differ from shingle stains in several important respects. They are not intended for protection and are generally used in connection with other methods of treating wood, hence creosote oil does not enter into the vehicle. Also, they are not generally intended to hide



Convenient way of holding a medium-sized brush for painting the strips of a trellis work.—(Photo. by the author.)

completely the original color of the wood but to modify such color and bring out contrasts of grain, etc. Hence the pigments used should not be too opaque. Finely ground siennas, umbers, and ochers are examples of suitable pigments. From 1 to 2½ pounds of suitable pigment is used to the gallon in a vehicle composed of about 70 per cent linseed oil, 20 per cent turpentine, and 10 per cent drier in the case of the so-called oil stains, while the varnish stains have a vehicle of thin varnish. Sometimes aniline dyes are used instead of the insoluble pigments mentioned. Very brilliant stains can be produced in this way, but such stains are very likely to fade. Water stains are solutions of dyes in water. These not only tend to fade but have the disadvantage of "raising the grain" of the wood.

BRONZE PAINTS

Bronze paints, which are frequently used for coating metal, such as radiators, consist of finely divided metal in a vehicle of celluloid varnish (so-called "banana oil"), being a solution of nitrocellulose in amyl acetate. This has a very disagreeable odor, and as a good bronze paint can be made with a pale China wood oil-resin varnish with a petroleum-oil thinner, this type is generally to be preferred. The pigment (finely divided aluminum) in aluminum-bronze paint usually amounts to from 15 to 19 per cent.

WATER PAINTS

The cheapest of all paints is whitewash, and for certain purposes it is the best. Lime, which is the basis of whitewash, makes a very sanitary coating and is, hence, to be preferred for cellars and the interior of stables and other outbuildings. Ordinary whitewash, made by slaking quicklime and adding water to pro-

duce a mixture of proper and uniform spreading consistency, affords the most sanitary coating, but does not adhere so well as does whitewash to which certain additions are made. Five pounds of quicklime will suffice to make about 1 gallon of ordinary whitewash.

The additions made to ordinary whitewash which tend to make a material which will produce a better or more lasting coat are quite various, such as salt, flour paste, milk, glue, cement, alum, zinc sulphate, sodium silicate, soap, etc.

The following recipe is a very old one, having been successfully used on wood, brick, and stone by the Bureau of Lighthouses for many years:

Slake half a bushel of unslaked lime with boiling water, keeping it covered during the process. Strain it and add a peck of salt dissolved in warm water; 3 pounds of ground rice put in boiling water and boiled to a thin paste; half a pound of powdered Spanish whiting and a pound of clear glue, dissolved in warm water; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible, with painters' or whitewash brushes.

For making small quantities of whitewash it will usually be found convenient to use powdered hydrated lime instead of quicklime. This product is already slaked.

Whitewash may be tinted by the addition of colors, but care should be taken not to use colors which are affected by lime. Yellow ocher, siennas, umbers, iron-oxide red, ultramarine blue boneblack, etc., may be used. If dry lampblack is used it must be first stirred in hot water containing some soap or in cold water containing borax, otherwise it will be found difficult to wet the lampblack.

CALCIMINES OR COLD-WATER PAINTS

Calcimines have as their bases whiting, clay, silicates, etc., instead of caustic lime, as in whitewash. These materials do not adhere, and it is necessary to use a binder of some kind, generally glue or casein.

The following recipes, taken from "White Paints and Painting Materials," by Scott, are representative of this class of material:

Ordinary white stock (calcimine).—(a) 16 pounds of whiting mixed until free of lumps with 1 gallon of boiling water; (b) $\frac{1}{2}$ pound of white sizing glue; soak 4 hours in $\frac{1}{8}$ gallon of cold water. Dissolve on a water bath and pour into 16 pounds of whiting mixed until free of lumps with 1 gallon of boiling water. This will make about 2 gallons, weighing $12\frac{3}{4}$ pounds per gallon. It is of proper brush consistency and may be used at once but is better after standing a half hour. This material will cover per gallon about 270 square feet on plaster, 180 square feet on brick, or 225 square feet on wood.

Cold-water casein paint.—8 pounds pure casein, 10 pounds air-slaked lime, 1 pound pulverized borax, 60 pounds whiting. Mix the dry ingredients thoroughly and keep in a sealed package until wanted for use, then stir in cold water (or, better, warm water) to produce a mixture of proper brush consistency.

Calcimine may be tinted in the same manner as whitewash, using only colors which are not affected by lime.

FLOOR WAX

While floors are very frequently varnished and look very well when newly treated, varnished floors are hard to keep in good condition. A waxed floor, on the other hand, may be kept in good condition indefinitely with a moderate amount of care. In fact, a properly

cared for wax floor improves with age, which is more than can be said for any other floor finish.

The following formula furnishes a very good floor wax:

	Parts by weight
Carnauba wax	2
Ceresin	2
Turpentine	3
Gasoline (sp. gr. 0.725)	12

The waxes are melted by heating in a vessel of hot water, and the turpentine and gasoline are then added and the mixture cooled as rapidly as possible, while vigorously stirring to produce a smooth creamy wax.

Another formula which has been found very good is:

Turpentine	pint.. 1
Beeswax	ounces.. 4
Aqua ammonia	ounces.. 3
Water (about)	pint.. 1

Mix the beeswax and turpentine and heat them by placing the vessel in hot water until the beeswax dissolves. Remove from the source of heat, add the ammonia and water, and stir vigorously until the mass gets creamy.

In making either of the above waxes be very careful to heat only by setting in hot water and have no flames in the room, since both gasoline and turpentine are very inflammable.

Floor wax should be applied in very thin coats and thoroughly rubbed with a heavy waxing brush or a heavy block wrapped in burlap or carpet.

REMOVING PAINT AND VARNISH

The most efficient method of removing old paint and varnish is by burning with a painter's torch. The

heat causes the film to soften and it can be scraped off. This method, however, can only be used on flat surfaces and where slight scorching of the wood is not objectionable. A hot solution of caustic soda (concentrated lye) 1 pound to the gallon, is also quite efficient. This should be applied with a fiber (not bristle) brush until the paint softens. This is very hard on the hands and also raises the grain of the wood and surfaces treated with it should be thoroughly washed with water and allowed to dry before repainting. It will also be necessary to sandpaper such surfaces.

There are a number of paint and varnish removers on the market, most of which consist of mixtures of benzol, acetone, and methyl alcohol, with frequently the addition of some waxlike body which retards evaporation of the volatile solvents, which are the real active constituents.

CARE OF BRUSHES

Brushes for applying oil paints must be well cleaned after using, though for keeping overnight it is generally sufficient to wrap them in several thicknesses of paper. Some painters keep their brushes overnight by putting them in water. If, however, the brush is not to be used for several days, the paint should be washed out of it. Turpentine is one of the most satisfactory materials for washing a brush, but it is expensive, and a brush can generally be washed as well with kerosene, which is much cheaper. After washing off the paint with kerosene the brush should be rinsed with gasoline or benzine, then thoroughly shaken and well washed with soap and warm water. As soon as this washing is complete the brush should be shaken thoroughly, so as to throw as much water out of it as possible, and hung up with the bristles down to dry. When dried the brush should be thoroughly protected from dust.

If much painting is being done, it is less trouble to keep the brushes in turpentine or kerosene. For this purpose hooks should be fastened on the inside of a pail with a close-fitting cover, the brushes being suspended either by holes in the handles or by loops of string, so that they hang in the kerosene or turpentine in the bottom of the pail. The bristles should be submerged in the liquid but should not touch the bottom of the pail. If kerosene is used for cleansing, it should be removed by shaking the brush and rinsing it in turpentine before using again with paint. Brushes used with whitewash or calcimine should simply be washed and not put in the same liquids in which the brushes for oil paints are kept. If a brush has been used for shellac varnish, it should be kept in alcohol or in the varnish itself. In general a varnish brush may be kept in the varnish in which it is used.

PRECAUTIONS TO BE OBSERVED IN PAINTING

Do not use any paints containing compounds of lead about stables or outbuildings where the fumes from decaying organic matter occur, since these gases are likely to darken the lead paints. Do not use with lead compounds any pigments which may liberate compounds of sulphur. For example, ultramarine blue, which contains sulphur in a form in which it may be set free, is a beautiful and very permanent blue and may be used with zinc white but should not be used with white lead or any other lead pigments. Prussian blue, on the contrary, does not contain sulphur and may be used with lead pigments.

Remember that turpentine and benzine are very inflammable; hence, special precautions should be taken not to bring paint containing these substances near any light or open fire.

Many pigments are poisonous, and the workman

should be particularly careful to remove all paint stains from the skin and not under any circumstances allow any paint to get into his mouth. A man should not eat in the same clothes in which he has been painting, and before eating should not only change his clothes but wash all paint stains from his skin. It is not advisable to use turpentine or benzine in removing paint stains from the hands, but by oiling thoroughly with linseed oil or, in fact, with any fatty oil and then thoroughly washing with soap the paint may be removed, provided it has not been allowed to dry too thoroughly on the hands.

FINISHING THE HARDWOOD FLOOR

After the hardwood floor is laid, it should be scraped and sandpapered to a smooth surface. This scraping should be done with a sheering cut lengthwise of the grain. Then sweep the floor clean and wipe carefully with a soft cloth until all dust is removed.



For finishing beech and birch with a wax finish, the directions given by the flooring manufacturers are as follows:

Scraping old painted surfaces vigorously with a wire brush, in order to remove the loose particles and get down to a firm base for the fresh paint.—(Photo. by the author.)

Natural Finish: First, fill with wood alcohol and light colored umber mixed to the consistency of thick

cream, and rub thoroughly into the wood. Never use benzine, which evaporates and may discolor. Wood alcohol, originally from the wood itself, penetrates hardwoods. Secondly, apply two coats of alcohol shellac and rub each coat well when dry. Thirdly, apply one coat of linseed oil and pumice stone and rub well. Fourthly, apply one coat of equal portions of wood alcohol and turpentine mixed and rub well. Fifthly, apply three or four coats of light colored floor wax, rubbing each coat thoroughly before applying the next. If an even colored finish is desired put a little cherry stain in the filler.

Special white finish for enameled bedrooms and bathrooms: First, fill with wood alcohol and best quality white lead and rub thoroughly into the wood. Secondly, treat same as above.

For finishing maple with a wax finish:

Natural Finish—White Clear: First, fill with umber and best quality white lead thinned with wood alcohol mixed to the consistency of thick cream, and rub thoroughly into wood. Secondly, apply two coats of alcohol shellac and rub well. Thirdly, apply one coat of linseed oil and pumice stone and rub well. Fourthly, apply one coat of equal portions of wood alcohol and turpentine mixed and rub well. Fifthly, apply three or four coats of light colored floor wax, rubbing each coat thoroughly before applying the next.

Clear: Finish same as White Clear, unless an even color is desired; then mix a little gray umber in the filler.

For staining maple, beech, and birch, the procedure is as follows:

The most successful process for staining maple consists in using a filler of wood alcohol and the best quality white lead stains, going in with this filler. Rub thoroughly into the wood. Follow this process for beech and birch, which take stains admirably, but a

thin, transparent stain should be used that will color the wood without obliterating its character. Try out on small surface, to see that the right color has been gained.

Oil stains are recommended when a stain is to be applied direct to the wood. Oil stains do not set quickly and give the operator longer time in which to work. The color should be worked into the wood and not allowed to remain on the surface. Rub off to an even tone before the stain hardens.

VARNISHING MAPLE, BEECH AND BIRCH FLOORS

A satisfactory method of varnishing maple, beech or birch floors is to thin the varnish by adding turpentine, the quantity to be added varying from 10 to 30 per cent, and applying directly to the wood.

When dry and hard, sandpaper lightly with No. 00 sandpaper to remove the small air blisters; wipe clean and give a coat of full body varnish just as it comes from the can. A third coat should be given in the same way and rubbed down with pulverized pumice stone and rubbing oil. Then the floor should be wiped dry.

Varnish does not dry so well at night, with or without artificial light, as in the daytime. Ventilation, temperature and light are important. Windows should be open to insure ventilation.

It is important not to use liquid fillers or shellac under varnish. The floor must be dry and clean before a drop of finishing material is placed on it. Temperature should be between 70 and 80 deg.

Portions of varnished floors subjected to excessive wear may be renewed if the work is undertaken before the wood is exposed and turns dark. Such portions should be cleaned with white soap and water and a thin coat of varnish applied. This should be rubbed well.

then coated with full body varnish and rubbed down to correspond with the remainder of the floor.

FINISHING OAK FLOORS

The finishing of an Oak Floor is a most important feature involving cost, color and finish desired. Personal taste and artistic or decorative effects are the guide for the floor finisher.

The "Clear" grade of Oak Flooring should have a natural Oak filler—color of Oak. For the "Select" and "Sap Clear" grades a light golden oak filler should be used, and after the floor is filled, it should be gone over with a little burnt umber mixed with turpentine to darken light streaks. This will make the "Select" and "Sap Clear" grades appear similar to the "Clear" grade, except that the color will be slightly darker. In filling the "No. 1 Common" grade, a dark golden oak filler should be employed, and the light streaks should be darkened in the same manner as the "Select" and "Sap Clear" grades. With a little care in laying this grade, splendid results can be obtained.

First—Treat the floor with a paste filler of desired tone, to fill up the pores and crevices. To thin the filler for application, one has a choice of using turpentine, benzine, wood alcohol or gasoline to get the right consistency. Never use a liquid filler. When the gloss has left the filler rub off with excelsior or cloth, rubbing against the grain of the wood. This will make a perfectly smooth and level surface. It keeps out dirt and forms a good foundation, which is the key-note of successful floors. Allow the filler twelve hours to set or dry. Then apply two coats of white shellac before applying the wax treatment. When varnish is to be used, give one coat of filler and one or two coats of varnish.

A wax or varnish finish may be used. The wax finish

is preferred by many, due to economy and ease of renewing places that show wear. The renewing may be easily applied by housekeeper or servant.

Wax Finish—The best method of applying the wax is to take cheesecloth and double it to get added thickness; then fold into a sort of bag. Put a handful of wax inside and go over the floor thoroughly. It will be found that the wax works through the meshes of the cheesecloth and

gives an even coating over the floor. This prevents waste and excessive wax in spots. After the floor has been gone over with the wax and allowed to dry about twenty minutes, it is ready for polishing. Rub to a polish with a weighted floor brush, first across the grain of the wood, then with it. (A clean, soft cloth may be used in place of



Painting porch banisters and stair ballustrades is a tedious job. The way to hold the small brush is here shown. Certain parts will require a side-to-side stroke, and others a straight up-and-down.—(Photo. by the author.)

the brush if desired; then a piece of woollen felt or carpet should be placed under the brush to give the finishing gloss. After waiting an hour, a second coat of wax should be applied in the same way and rubbed to a polish.

Varnish Finish—This is usually more expensive than

the wax finish, but it gives a very hard surface, which at the same time is elastic. One or two coats should be applied after the application of the paste filler. Any of the standard Hardwood Flooring Varnishes will give good results.

Floor Oil Finish—When a high class finish is not desired an economical finish may be had by the use of light flooring oil, made expressly for this purpose by many paint and varnish houses and oil makers; it serves as a filler as well as a finish, and is particularly recommended for Oak Flooring in public institutions, office buildings and stores. This oil keeps the dust from rising and preserves the floor.

HOW TO CARE FOR OAK FLOORS

There are several preparations put up by varnish and wax manufacturers which give excellent results for cleaning and the care of Oak Floors, that may be bought at any department, hardware, drug or paint store.

Never use water, oil, kerosene, turpentine, soap, or any other cleaning agents, except as follows:

Shellac Finish—If water has been spilled upon the floor, turning it white in places, moisten a soft cloth with a little denatured alcohol and lightly rub the spots, which should immediately disappear. Do not repeat this operation too often, however, or the finish will be entirely removed. Shellaced floors sometimes take on a clouded or grayish appearance due to dampness in the air. This condition can usually be greatly improved by the same treatment as above. If the finish has become so soiled that it is desirable to remove it entirely, first scrub the floor with a standard brand of varnish remover (this is preferable to alcohol, as it does not evaporate as rapidly and insures sufficient time to remove the Shellac, thus allowing a smooth even tone)

and then bleach it with oxalic acid (one tablespoon to one gallon of water)—never use lye, as it turns the wood black and ruins the surface permanently. After all moisture has evaporated the original finish may be applied.

Varnish Finish.—If the finish has become badly worn, thoroughly scrub it with a brush, a good cleanser and water (never flood the floor). After it has dried out, apply a thin coat of varnish; or in event that time cannot be allowed for the varnish to dry, wax may be substituted.

Wax Finish.—Waxed floors should be dusted with a broom covered with cotton flannel. Keep a can of wax on hand, and should the finish become worn in the doorways or elsewhere, apply a thin coat, rubbing well into the wood. Allow the wax to dry for one hour and then polish thoroughly. Before rewaxing the floor, scrub it thoroughly with turpentine and a piece of cheesecloth.

CHAPTER XIV.

THE A B C OF PLUMBING IN THE HOME

THE plumbing of the home accomplishes two main purposes; first, it brings fresh, clean water into the home for drinking, cooking, washing, bathing and other purposes; secondly, it removes various wastes. Thus the plumbing has two main divisions, namely, that having to do with the water supply, and that having to do with the disposal of waste.

Then, too, the plumbing of the home is affected by three factors: first, the kind of water supply, if any, that is available; secondly, whether or not a public sewer is available; thirdly, whether or not plumbing codes are enforced in the locality. If a public or private water supply is available, the problem of obtaining the necessary water for the home is already solved. If not, which is the case when building in the open country, it becomes necessary for the home builder to install some form of water supply system of his own, unless he is satisfied to draw water from a well in the way of his ancestors. If a public sewer is available, there is no sewage disposal problem to be solved, since the home builder has merely to connect up with the public sewer. But if there is no public sewer system,

it then becomes necessary for the home builder to install his own sewage disposal system, unless he is satisfied with the antiquated back house or the deplorable cesspool. If a plumbing code is in force in the locality selected for the home, it becomes necessary to comply with certain rules and regulations regarding the plumbing, which materially increases the cost without real necessity for so doing, as will be described further on.

KEEPING SEWER GASES OUT OF THE HOUSE

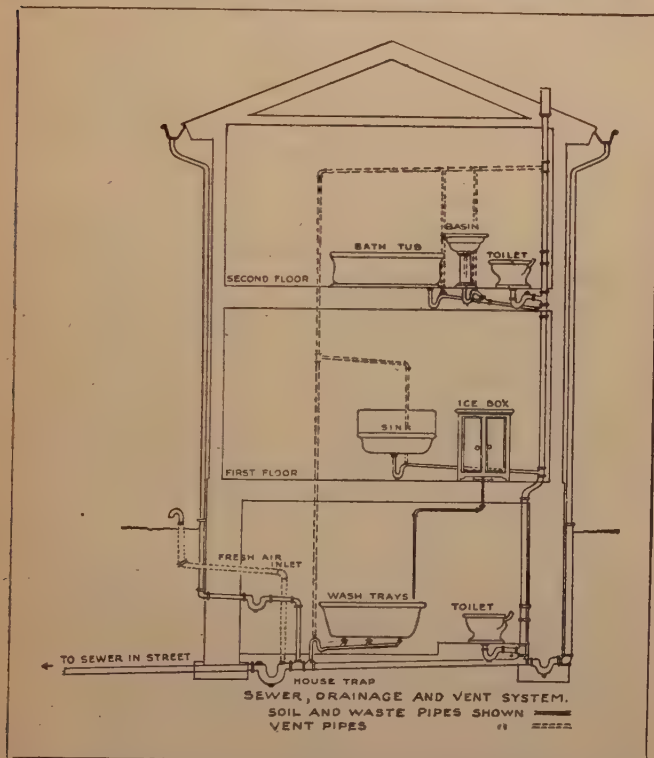
The theory of modern plumbing is to prevent the escape of sewer gases into the house. Regulations covering plumbing installation are pretty general throughout the country, and the successful accomplishment of this once difficult task is almost universal.

The accompanying sketches will give the reader a clear idea of a simple plumbing installation. In a general way, the house drain connects with the sewer system, whether that be municipal or private. The connection with the sewer system is graded to have a sufficient slope to the sewer connection.

A clean-out should be placed where the drain enters the house, and at other points where the pipe takes a right angle turn. The house drain should be large enough to carry off the maximum amount of sewage that it will be likely to receive at any time, and yet if it is too large it will not be self-cleaning. This detail, as well as the pitch of the drain, should be left to the skilled plumber or the architect.

A fresh-air inlet not less than four inches in diameter should connect with the house drain, with the mouth of this air inlet sufficiently removed from any opening into the house. A soil stack joins the house drain and is run up through the house to receive the discharge from the various fixtures in the system.

Where the house is particularly large, there are several such soil stacks; but careful planning will en-



Waste pipes of a typical plumbing system, showing the soil and waste pipes as well as the vents and fresh-air inlet.
—(Courtesy Copper & Brass Research Association.)

able the average house to be adequately provided for with one stack.

Now between each fixture and its opening into the soil stack is placed some form of trap to prevent the

outlet of foul air and gas from the stack. A good trap must be large enough to hold a sufficient amount of water to withstand loss of evaporation for a long time without breaking the seal. The usual trap takes the form of an S lying on its side: all water closets include a sharp upward and downward passage, which ensures a water seal against the sewer gases; lavatories, sinks, wash-tubs and other fixtures are provided with similar traps.

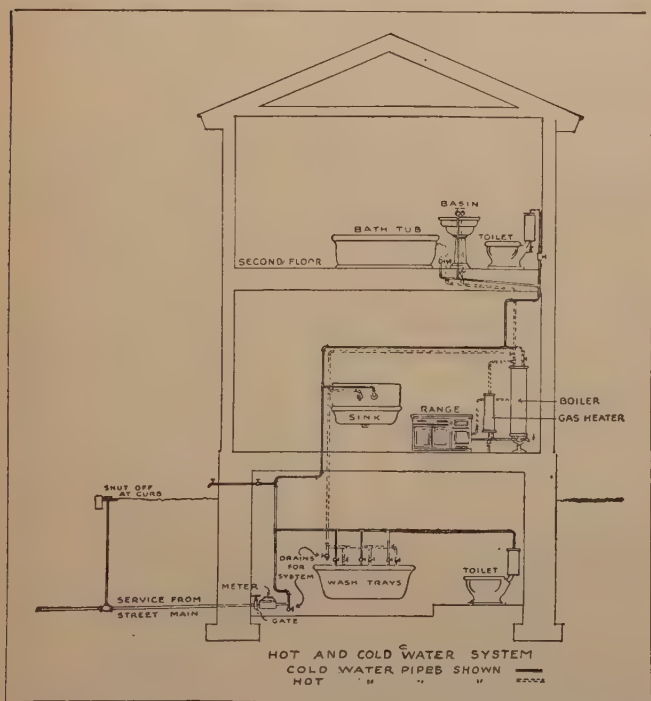
A small vent pipe connects each trap with the open air, so that the water seal in the trap may not be broken by the siphoning action of the flow of water through the main soil line. Good practice and economical construction require a form of lay-out that will allow the vents from all the traps to be connected into one main vent stack. From the point above its connection with the highest fixture, the soil stack is converted into a vent stack, and the pipe connecting all the vents should converge into the vent stack at this point. This stack should emerge from the roof in a vertical direction to a length of about twelve inches, and in a position located well away from any window or other opening into the house.

It is wise to increase the size of the pipe by one inch from a point one foot below the roof, as in cold climates the outlet is in danger of becoming choked with hoar frost during winter months. The opening about the stack where it passes through the roof should be permanently weather-proofed with flashing.

SIMPLIFYING THE PLUMBING IN THE ABSENCE OF PLUMBING CODES

The vent pipes referred to in the foregoing are called for by most plumbing codes, where they are in force. The object of these vent pipes is to make certain that the air pressure of the room will not force out the

water entirely out of the trap, thus eliminating the seal against sewer gases, when the discharge of a water closet on a floor above sends a mass of water down the drain pipe and causes a vacuum behind it. Back-venting, as shown in our drawing, reduces this danger of



Hot and cold water piping of a typical plumbing system.
—(Courtesy Copper & Brass Research Association.)

siphoning, and therefore most plumbing codes insist on back-venting.

However, there have appeared during the past few

years various types of anti-siphonable traps which do not require back-venting. Unfortunately, the authorities have been slow to recognize the possibility of the anti-siphon trap and have not changed their codes. Still, when no local plumbing code is in force, the home builder may save considerable money by installing reliable anti-siphonable traps and eliminating the elaborate and expensive system of back-venting.

The drain pipe should be lower than any of the fixtures in the house. This seems to be a perfectly obvious fact, yet every so often it is overlooked in house building. Thus if the drain pipe is brought down along the wall of the basement, it stands to reason that when laundry tubs are installed in the basement at some future date it will be impossible to drain them with the existing drain pipe. The same may be said if it is decided to install an extra toilet in the basement. The author came across an interesting case of this kind. The sewer system was just being installed in a village which had been getting along for the past two hundred years or more without anything more elaborate than cesspools and back houses. In one section of the village the sub-grade of the street consisted of solid rock. In order to save considerable money, the village decided to lay the sewer in a very shallow trench blasted out of solid rock. The consequence was that when the property owners endeavored to connect up with the sewer, they found that even with a very slight fall the drain pipe came into their house higher than the level of the first floor. Consequently, it was impossible to use fixtures of any kind on the first floor, except to have them drain into cesspools as in the past. To this date this condition has not been rectified, because of the expense involved; but it points out the necessity of having the drain pipe and the sewer well below the level of the lowest fixture in the home.

SEWER, CESSPOOL OR SEPTIC TANK?

In these days of modern sanitation the average American community of any pretensions whatsoever has a public sewage system, consisting of sewer pipes laid under the streets and available to the property owners. At the time the foundation of the house is being constructed and the property is more or less messed up, a trench is dug out toward the center of the street, where the sewer generally passes some six to twelve feet below the surface, sometimes more. Connection is then made with the sewer, just as connection is made with the water mains. Tile pipe or cast iron pipe with cemented joints is used, with a slight fall towards the sewer main.

It is for the community authorities to dispose of the sewage which is poured into the sewers. In the past the practice has been to dump the sewage into a nearby river or harbor, which is the simplest solution of the problem. However, many of our waters have been polluted by such practice, and already there are clear indications that we cannot continue to dump our waste in such a haphazard manner. As time goes on this practice must lead to a serious menace to health. Therefore, various methods of disposing of sewage have been worked out, both here and abroad. These methods have to do with screening and treating the wastes before discharging them into a river, or with the chemical destruction of waste on a large scale, rather than the mere scattering of waste.

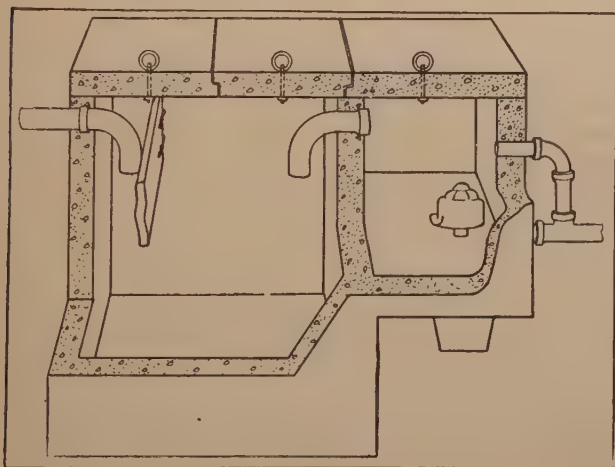
But when the home builder has no sewer system at hand, the problem of sewer disposal is at his very door. It is for him to take care of the wastes from his home. In former years waste water was merely thrown into the back yard, there to form little gulleys to lower land and to soak into the soil as best it could.

The privy, or back house took care of other waste. With the improvement in our way of living, however, the back house has been discarded almost universally, and in its place we have the modern bathroom and toilet in the home, whether there is a sewer or not. Unfortunately, where there is no sewer the general practice has been to use the simplest kind of sewage disposal, which is the cesspool.

Nothing could be more unsanitary than the cesspool. It is little more than a collecting basin for the sewage waste, from which there is more or less seepage through the surrounding soil. The usual cesspool is simply a round, or square, or oblong hole dug in the ground, with its sides laid up with loose masonry. Solid masonry is laid near the top of the cesspool walls, which are curved toward each other so as to provide a man-hole which is normally covered with a concrete or stone slab. Some localities have distinct health laws forbidding the construction of cesspools except with solid and non-seepable masonry. Such construction, it must be obvious, makes the cesspool nothing more than a tank which accumulates solids and liquids until it becomes filled, when it must be emptied. This, of course, is an unsatisfactory state of affairs. In order to evade the law the unscrupulous builder uses mud instead of mortar for his masonry wall, so that the finished wall, upon a cursory examination, has the general appearance of a solid masonry wall. In due course the mud dissolves and allows seepage through the loose stones.

In a light soil or in gravel, the cesspool works well, so far as the mechanics of the thing are concerned. The solids accumulate very slowly, while the liquids pass off through the surrounding porous ground. In clay or dense soil, the cesspool works poorly if at all and it requires constant attention. When the cesspool is full, the sewage backs up into the house, with

unpleasant consequences. Cleaning out the cesspool is by no means the most pleasant feature of country life; but, fortunately, every community which has cesspools generally has a man who engages in this kind of work. His unenviable job brings him a good remuneration, to be sure, which makes the inoperative cesspool a very expensive proposition.



Broken-away view of a concrete septic tank which may be readily constructed. The left-hand compartment is the settling chamber, and the right-hand one the siphon chamber.—
(Courtesy Portland Cement Association.)

Cesspools are a menace to community health. Their seepage permeates through the soil in all directions. It is out of all control, which is what makes it so dangerous. Indeed, the health authorities have often pointed out the surprising fact that the old-time and despised back-house is more sanitary than the cesspool. At least the area covered by the former may be definitely located and avoided, and, what is more, na-

ture takes care of the disposal problem in her own way being given the opportunity to do so.

Inventive genius has come to the assistance of those who have no public sewer system at their disposal. Septic tanks solve the problem of disposing of house wastes from a modern plumbing system where a city sewer is not within reach. It must be understood, however, that the septic tank is not offered as a substitute for a modern sewerage system. It is intended only as the best substitute where there is no sewer. Properly built and taken care of, a septic tank has many advantages over the simpler and less expensive cesspool. Most important of all, the septic tank will transform the wastes from the house plumbing so that their final disposal in a safe, sanitary manner is very simple. The only disadvantage of the septic tank is that it requires considerable ground for its satisfactory operation.

Septic tanks are manufactured either in whole or in part, so that the home builder can buy a complete outfit or build his own on the premises. Concrete septic tanks are not hard to build nor are they expensive. Once in operation, they cost little or nothing to keep in order and may be relied upon to give satisfactory service indefinitely.

THE SEPTIC TANK IN THE MAKING

Usually a septic tank is built of two compartments, as shown in the sketch on page 351. The first or left-hand compartment is sometimes referred to in several ways. Generally it is called the settling chamber. The second, or right-hand compartment, which is smaller than the first, contains a device known as a siphon, and for that reason is called the siphon chamber. The siphon chamber receives the overflow from the first compartment, and by means of the siphon,

which is automatic in operation, is emptied at regular intervals into a tile line which leads to a disposal field where the discharges leak out through the open joints of the tile line and so seep into the soil.

The principle on which the septic tank operates is one of rotting or decomposition; that is, the solids and semi-solids which enter the first compartment from the house drain are digested or liquified by bacteria such as develop in all vegetable or animal matter when such matter starts to rot or decompose.

Experience has proved that in the septic tank, sewage will, if confined in a practically airtight and dark compartment, soon commence to "break up" in this manner, due to the development and action of these bacteria. These feed, so to speak, upon the solids and semi-solids in the wastes, thus converting them into gas and relatively harmless compounds. It should not be thought from this, however, that the action taking place in the tank will destroy disease germs. The discharges from the tank through the operation of the siphon must still be properly cared for to prevent them from being a possible source of disease.

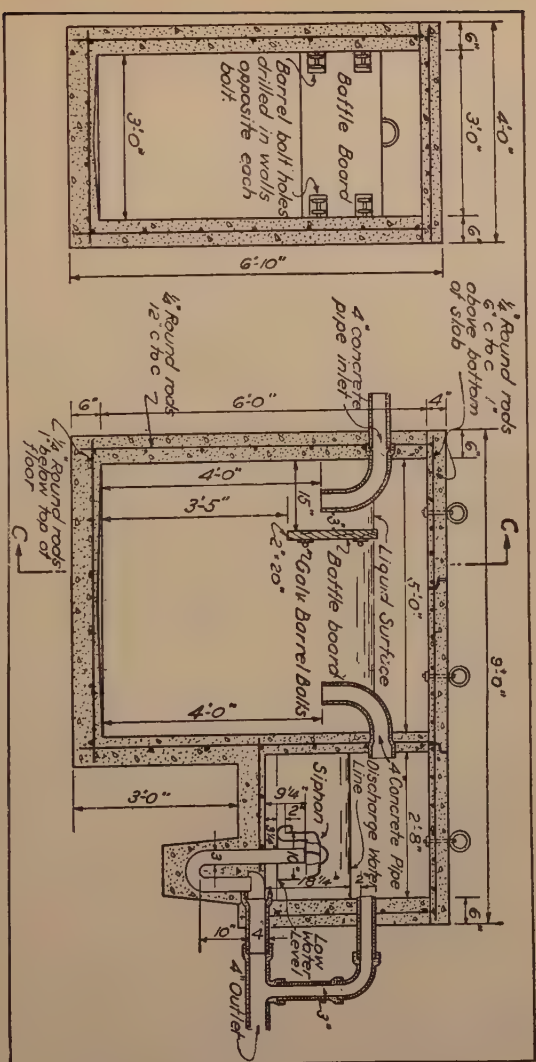
Sewage must enter from the house at one end of the tank and leave at the other end. A grease trap must be placed in the line from house to tank. The flow through the tank should be slow and as uniform as possible. If the flow is not slow, the solid matter will not settle. Rapid flow in the center and no movement at the sides interferes with the most effective working of the bacteria that develop in the scum which forms on the liquids in this compartment a short time after the tank is put into operation. Sewage must enter the tank below the normal level of contents. A rectangular tank is best.

There are two methods in common use for disposing of the discharges from the siphon chamber resulting from the frequent emptying of this compartment by

the automatic siphon. If the surroundings are such that a certain area of ground can be set aside for the purpose, surface, or broad irrigation, as it is called, is a satisfactory means of disposing of tank discharges. This means allowing the liquids discharged by the tile line from the siphon compartment to flow over the land where they are acted upon by the sun, and by bacteria which live in the upper layers of the soil and require air at least for their life and work. Therefore the soil cannot handle these wastes properly below a certain distance from the surface, because of limited air supply. In the final disposal of sewage by broad irrigation, it should be the aim to select an area, or disposal bed, as it is sometimes called, where the wastes will not be washed immediately into some nearby stream, thus fouling the water.

Discharges from the siphon compartment should be carried to the disposal field by a tile made of dense, non-porous tile, laid with cemented joints. The outlet should discharge into an open ditch which may be about 12 inches wide by 6 inches deep, with side ditches connecting to this main, one at right angles at intervals about 6 feet apart. These should be dug to such a grade that the fluids will quickly and easily spread over the whole area. Rapid distribution of the liquids is necessary to prevent the soil from becoming clogged up as it would if a small area of the field had to receive and dispose of all the discharges from the tank. Where it is possible to do so, it is advisable to provide two or even three disposal areas so that one or two can be "resting" while the other is in use. This also will prevent the soil from becoming clogged.

Another method of final disposal consists of what is called subsurface irrigation. This means discharging the contents of the siphon compartment into lines of 4-inch drain tile laid with open joints so that the liquids may leak out of these joints and filter into the



Details of a concrete septic tank (see page 351) which is simple to construct and which, once in operation, costs little or nothing to keep in order and may be relied upon to give satisfactory service indefinitely.

—(Courtesy Portland Cement Association.)

soil. Such a tile should be laid with a grade not greater than 2 inches per hundred feet. To prevent soil from entering the tile line through open joints and thus clogging it up, joints may be covered with flat stones or pieces of broken tile of larger diameter. In both systems all connections between the house and septic tank and from the septic tank to the disposal field should be made with tight joints. This means that there should be at least 200 feet of tile laid from the siphon chamber before the sewage is discharged into open trenches or before the tile are laid with open joints. Obviously, the tile line should be placed below the frost line to avoid winter troubles.

Once started, the septic tank is self-operating on account of the automatic siphon. Being discharged at intervals from the siphon compartment, the tile line is suddenly flushed, then emptied by leakage out of joints into the soil, hence the soil is allowed to rest until the next discharge brought about by the siphon. These intermittent discharges keep the soil from clogging, as would happen if the tank were continually discharging a trickling flow into the tile line.

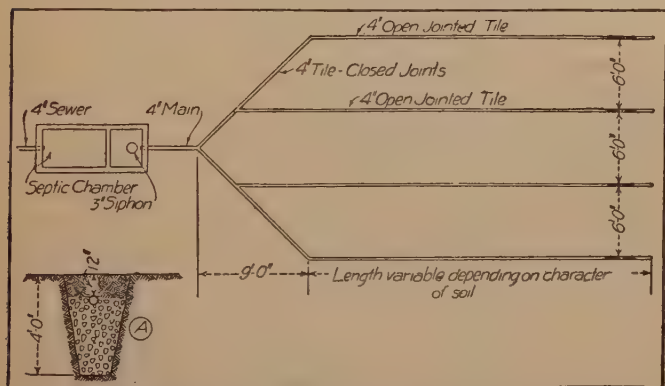
Experience seems to prove the advisability of building a septic tank with a capacity sufficient to handle a 24-hour flow of sewage or wastes from the average household. Capacity is usually estimated by considering that the discharges into the tank will range from 30 to 50 gallons per person per day. The length of the tank should be about twice the width, so that it will be possible to obtain a uniform velocity of flow through it. This will prevent any great disturbance of the scum.

Septic tanks can be readily constructed of concrete without more than average skill. For complete constructional details, the reader, if interested, should write to the Portland Cement Association. Furthermore, anyone thinking of building a septic tank should

write to their state or local health authorities who will be glad to advise as to the best system for each particular situation. Practically all State boards of health issue bulletins treating of the sanitary disposal of household wastes.

HOT AND COLD WATER SUPPLY

The water supply of the home starts at the water main which has been tapped, or calls for an elaborate



Layout of septic tank and tile lines when the final disposal system is planned for sub-irrigation. At "A" is shown a method of arranging tile lines which is sometimes necessary where the soil is dense, like in clay.—(Courtesy Portland Cement Association.)

private water supply plant. Here again, as in the case of the sewage disposal, the property owner in a modern village or town or city is to be envied, for he has a public water supply which is available for his every need. The water main is tapped and a service pipe is brought into the basement, where it usually passes through a meter which keeps tabs on the amount of water consumed by the household. Close to the water

meter there is generally a drain, which enables the plumber to drain the pipes of the entire house whenever it is necessary to do so, such as during freezing weather, when the house is left unoccupied and unheated. The cold water is piped to various parts of the house.

Cold water is also converted into hot water, by means of some form of water heater. One of the simplest forms of water heater is the old reliable coal range with its water-back and its ungainly boiler or tank. The size of the water-back is generally figured out on the basis of 2 square inches of heating surface to each gallon storage capacity in the boiler or tank. Thus while the coal range is being employed for heating purposes and for cooking, it is also warming water which is stored in the boiler.

This method of obtaining hot water has its disadvantages. For one thing, the coal range is not operated in the summer time, so that some other system of heating water must be resorted to during warm weather. Again, the water-back is by no means the most efficient way of heating water. Further, the coal range is dirty and inconvenient, and is being discarded for oil or gas in the modern home, to a very great extent.

There are special hot-water coal-burning stoves available which may be placed in the kitchen or the basement, and which heat a large quantity of water to be stored in a large tank for use as required. These coal stove hot-water heaters are quite economical.

Still another method is to place heating coils in the usual furnace or boiler of the heating plant. The general idea is that in this manner hot water may be obtained with no additional cost for fuel. As a matter of fact, the old rule of nothing being obtained for nothing still holds true. Heating coils in the usual heating plant furnace or boiler serve to obstruct the

fire pot, chill the fire, overheat the water in cold weather and underheat it in warm weather. During the summer, of course, such a heating plant is inoperative. Nevertheless, as a mere accessory to some more satisfactory type of water heater, a heating coil is not to be permanently condemned.

Perhaps the most satisfactory form of hot-water system today is the gas hot-water heater. Such a heater is generally connected with a boiler for storage purposes. However, it can be made to deliver water directly into the pipes of the building when there is a rush call for hot water, which has caused this type to be known as the instantaneous gas heater. If the water is taken directly from the coils of the heater, it requires a rather large heater and an alarming consumption of gas to obtain instantaneous hot water. Hence the better plan is to use a storage boiler in conjunction with the heater, the boiler causing a marked reduction in the size of the heater. These heaters can be so arranged that the water in the boiler is maintained at an even temperature by thermostatic control. The heater has a pilot light which burns all the while, and the main burners are only flashed on when there is need of heat for the water.

Where gas is not available, use may be made of an oil hot-water heater and a standard boiler for storage purposes. The oil burners may be of the wick or wickless type, but in either event they will be found quite satisfactory. One or more burners can be operated at a time, so that the demand for hot water can be met.

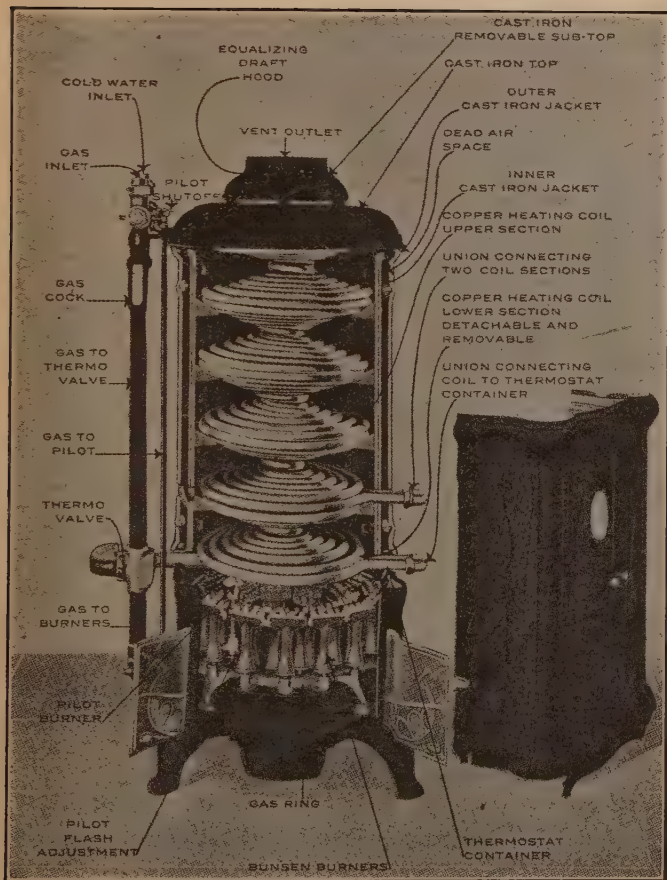
Various electric hot-water heaters are available today, although the cost of electric current in most localities makes this method quite prohibitive in cost. One type of electric heater is the instantaneous type, which is connected directly with the faucet or takes the place of the faucet. The moment the water is turned on, the cold water, passing through heater

tubes, is heated to anything from luke warm to the boiling point, depending on the consumption of electric current and how fast the water is passing through. This requires several thousand watts in the case of a good-sized stream of water, although for a slow trickle of water about 600 watts is ample. Needless to say, instantaneous hot water via the electric method has a disastrous effect on the home-owner's pocketbook.

Another method of applying electricity to the heating of water is to use an electric heater in conjunction with a boiler. In this case the heater stores up heated water in a boiler, and when the temperature has reached the desired degree the heater is shut off. This may be done by a manually-operated switch. The switch is turned on when hot water is desired, and at the end of 20 minutes to half an hour a boiler-full of hot water is available. Again, it may be handled by means of a thermostatic control, which takes care of the heater.

THE PLUMBING JOB

Every plumbing system should be given two tests—one when the “roughing in” has been completed, and another after the fixtures and fittings are in place. For the roughing tests, the openings should be closed up temporarily and a water pressure of at least 10 pounds applied to the whole system, which should then be given a most careful examination for leaks, especially those likely to occur in out of the way places. If split hubs or defective pipe are found—and they may be despite the utmost care on the part of the manufacturer—they should be removed and replaced by perfect ones. The final test may be in the form of pungent smoke pumped into the system. Any large leaks will make themselves known by the sight of escaping smoke and small ones may be detected by the odor of



Representative instantaneous gas water heater, open, to show the copper heating coils, thermostatic temperature control over burner, the power spout-flame burners, and double shell with large air insulation between.—(Courtesy The Humphrey Company.)

the smoke. Soap suds may be applied to any suspected places, and if there is a leak, bubbles will show themselves.

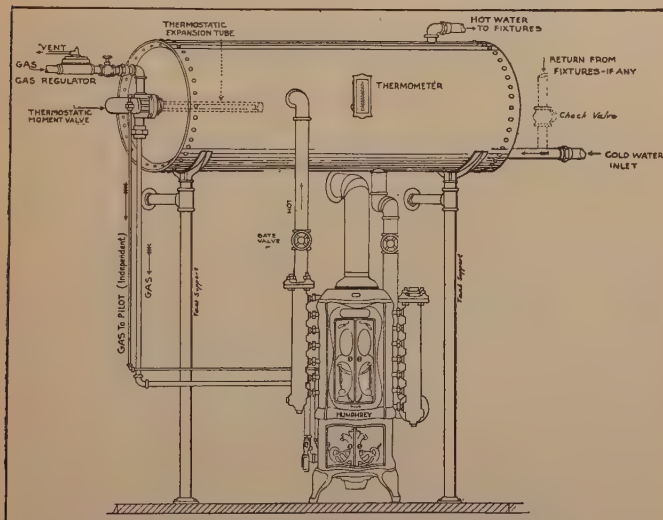
The question of what piping to use is an important one. The usual plain pipe is inexpensive, and that is about all that can be said in its favor. However, it is not inexpensive when considered in terms of the life of the house. It does not last. Furthermore, since much of the plumbing in the average home is painstakingly carried up between the walls and between the floors, it is not readily reached for changes of any kind. Hence the home builder should give some thought to more lasting piping. Wrought iron has remarkably good wearing qualities, and its additional cost over plain pipe is slight compared with its advantages.

The superiority of brass pipe and fixtures is so well known that brass would be universally used were it not for its higher first cost. But the difference is usually over-estimated, and therefore brass piping does not receive serious consideration. It is stated on the best authority that brass pipe in both hot and cold water lines can be installed in a \$15,000 house at an added cost of but \$40 to \$75. It is well to remember that brass cannot rust. It will give uninterrupted, rust-proof, expense-proof service as long as the building stands. Furthermore, a smaller sized brass pipe will do the work of a larger iron pipe, because the smoother interior surface of brass pipe permits water to flow through more freely, hence a greater volume of water will pass through a brass pipe than through one of iron. This disparity in favor of brass becomes greater as the iron pipe fills with rust.

THE FIXTURES OF PLUMBING

When it comes to bathroom fixtures and plumbing fixtures in general, there is little that need be said.

It is simply a question of taste combined with the limitations of the pocketbook. One gets precisely what one pays for in this game. Low prices bring poor quality fixtures, although these may be plenty good enough for the inexpensive house. The fixtures, like everything else in the house, should be in harmony with the general scheme, and it is quite as ridiculous to install a heavy porcelain build-in bath tub in the modest



Installation of gas hot-water heater used in connection with storage tank, giving hot water service at the turn of a faucet. The water in the tank is always hot, because of the thermostatic control.—(Courtesy The Humphrey Company.)

bungalow as it is to have a uniformed chauffeur for the "flivver."

Modern fixtures come in solid porcelain and enameled iron. While the former are no doubt more beauti-

ful, the latter serve the purpose equally well in the modest home. It should be remembered that the built-in type of bath tubs, especially the solid porcelain kind, are exceedingly heavy and the joists under such fixtures should be reinforced to carry the additional weight.

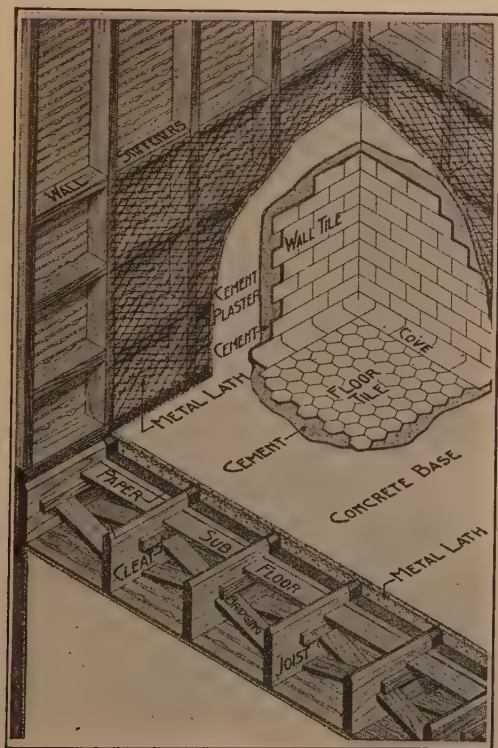
The bathtub can be enameled ironware; the washbowl vitreous or enameled ironware; the kitchen sink enameled ironware; the water closets vitreous ware; the water closet tank vitreous ware; the laundry tubs enameled iron, cement or soapstone. The durability of enameled ironware depends upon the thickness of the enamel baked on to the iron. A good thick enamel will give indefinite service.

The traps, cleanouts, faucets and exposed parts of the fixtures are important from both a service and economy point of view. In the first place, these fittings are made of brass. Brass costs money, depending upon its thickness. Even so, it is better to buy plenty of metal rather than too little. Water faucets should be of good quality, inasmuch as they are in constant use. In the case of nickel fittings, it is better to pay a little more and get a heavier plating, which will wear much longer than a thin, inexpensive plating.

Laundry tubs should be placed at a convenient height and where they will receive adequate light. This same precaution also applies to kitchen sinks. The sink should be as near the pantry as possible and sufficiently distant from the kitchen range so that persons working at the sink will not be uncomfortable from the heat of the fire. The height of the kitchen sink should be at least 36 inches for the comfort of the majority of persons. One of the chief causes of complaint from housewives is that the sink is set too low. The faucets should extend out far enough to permit utensils to be filled easily.

SUPPLYING ONE'S OWN WATER

When it comes to water supply, the property owner in the city, town, or progressive village is to be envied.



The carpentry of the bathroom, showing the special construction to take the metal lath and the cement floor (see page 311).—(Courtesy Weyehaeuser Forest Products.)

Generally he does not appreciate the convenience of a public water supply, because he is too familiar with it

and has come to take it as a matter of course. But to the property owner in the open country or the rural village without a water supply system, the matter is quite different.

There are so many factors that enter into the developing of a private water supply system that little can be said in the way of specific details. The usual source of water is a well, and sometimes a spring. Some method must be employed to raise the water so that it may be available in running form in the household. Several methods are available for this purpose. One is to pump the water out of a well and into an elevated tank, which may be on a tower or in the attic of the house. An electric motor, gasoline engine, wind mill or other form of motive power may be used. The tank usually has some form of control which shuts off the pump when the water reaches a certain level.

The elevated tank idea of late has been replaced by pressure tank systems, in which the water is pumped into an air-tight tank so that as it fills the tank it compresses the trapped air. Then, when the water is released, it is forced out by the expanding air. The force of gravity of the elevated tank is replaced by the compressed air. The pressure tank may be placed anywhere, and it is safe from freezing, which is not always the case with the elevated tank.

Then there are water supply systems which require no water storage tank. Instead, a pump is placed directly in the well or other source of supply, and the powerful air pressure from a compressed air tank insures a constant stream of fresh water the moment a faucet is turned, and right from the well or other source of water. A motor-driven pump maintains the air pressure in the tank. A small pipe takes the air to the pumps, which are located in the various sources of water. The advantage of such a system is that the same motor-driven pumping plant can supply power

for a number of pumps, for obtaining pure drinking water, cistern water, and other water for various uses.

There are so many factors that enter into the developing of a private water-supply plant that one will do well to write to the various manufacturers of water systems, stating the nature of one's particular problem and then sifting the various replies and suggestions for the best solution of the problem at hand.

THE DANGER OF FREEZE-UPS AND HOW TO AVOID IT

The greatest danger to the average plumbing system is from freeze-ups. If the home is built where winter weather is mild, the home owner will have little to worry about. If the home is located where sub-zero weather is a certainty, however, the home owner will want to be sure that his plumbing system is "freeze-up proof."

To avoid freeze-ups, the pipes should not be run within an outside wall. If the location of the bathroom is on an outside wall and it becomes necessary to run pipes "next to the weather," some good standard anti-freeze pipe covering should be used. Also, it is well to make sure that all short bends and angles are eliminated. If the basement is cold, the pipes may have to be insulated. Sometimes openings beneath floors connected with smaller openings to the weather—due to failure on the part of the carpenter or other workmen to plug tiny holes leading to the outside of the home—cause freeze-ups. These things should be watched for, even though they seem small and perhaps unimportant.

If the home builder has the slightest doubt about the possible freezing of his plumbing system, it is best to insulate the pipes and all parts of the plumbing system exposed to cold.

It is possible to purchase what is known as frost-

proof water closets for homes located in the country where closets are placed in cold rooms.

It goes without saying that water supply pipes should be buried well below the frost line, which does not extend below 18 inches in reasonable cold localities. Not only water supply pipes, but also waste and drain pipes should be placed below the frost line, otherwise trouble may be experienced.

In extremely cold weather the plumbing must be drained of all water if the house is to be left unheated. The pipes are drained by means of the drain placed at the lowest point in the plumbing system, after the water supply has been shut off at the point where the main enters the house.

CHAPTER XV.

THE HEATING PLANT AND HOW IT WARMS THE HOUSE

IF the buying season for houses were in the dead of winter instead of spring and summer, the heating plant would receive the attention to which it is entitled. Instead, the buyer and the builder pay little attention to the heating plant, because their thoughts are far removed from the not altogether pleasant subjects of snow, bitterly cold winds, and coal bills.

Again, if the subject of heating plant does come up, the buyer of a house is usually greeted with the rather pleasant bit of information that this particular heating plant requires virtually no coal even in the coldest weather. It is surprising how many economical heating plants are to be found in houses offered for sale. Indeed, the matter of coal consumption has been responsible for a goodly share of the falsifying of facts that goes along with the sale of houses. The first cold spell soon discloses just how efficient is the heating plant, and shatters the illusion of the near-fuelless house.

MAKING THE HEATING PLANT FIT THE HOUSE

In building a home there is little excuse for installing the wrong kind of heating plant. In this respect the home builder is more fortunately placed than the home buyer, since the latter must take what is already installed, although it is always possible, at considerable expense, to rip out the existing equipment and install new equipment.

One should make sure to install a furnace or boiler large enough for the demands of the home. Plenty of heat is required at an economical cost. Heating cost is, if one lives in a part of the country that has its cold seasons, a continuing major expense item; so that it is a measure of true economy in the first place to select the most appropriate heating system available. This consideration has to do particularly with the question of the capacity of the heating plant, rather than the kind of heat. Fortunately, the architect or the contractor or the purveyors of heating systems will inform the home builder as to the proper size of heating plant for the home in question.

When it comes to selecting the kind of heat to be used, this is a question of cost, design of the home, location, and exposure. Unfortunately, the item of cost generally decides the issue, so that the best kind of heating plant is not always selected for the inexpensive home. Often it would be far better for the home builder to leave off the sun parlor or postpone the fireplace or do away with some other item, so as to have money available for the best kind of heating system. After all, a home is not a home unless it is comfortable in winter as well as in summer.

The matter of economical and sufficient heat does not end with the installation of the appropriate heating plant. There still remains the matter of procuring suitable fuel, and then operating the heating plant

in the correct way. To this end the home owner must master every detail of his particular heating plant and take the necessary pains to exact the last bit of heat from every bit of coal thrown into the fire box. Especially is this matter significant at this time, when coal is selling at higher prices than were ever believed possible. Fortunately, the manufacturers of heating plants are always ready to supply literature and instructions on the economical operation of their products.

THE DOLLARS AND CENTS OF THE HEATING PLANT

Past generations got along with fire places which, in time, were replaced by the more efficient individual stoves for various rooms. The stove represented a marked improvement over the fire place and gave far more heat than the latter. However, the nuisance connected with carrying coal to the various stoves scattered throughout the house, as well as the mussy job of removing the ashes from the various stoves, brought about the central heating plant idea which is now almost universal. Aside from the bother and dirt connected with individual stoves, it was found more economical to operate a single large stove rather than a number of stoves. Hence the first step towards the central heating plant idea took the form of an air heating and distributing system, known as hot-air heat. In this system cold air is brought to the heated sides of a large stove which is surrounded by a light sheet-metal casing. As the air is heated, it rises through large ducts which discharge the warm air into various rooms in the house. Cold air immediately rushes in to take the place of the warm air which has gone up the risers, as the large ducts are called, and the process is repeated over and over again. The cold air is generally taken from outdoors, so that fresh

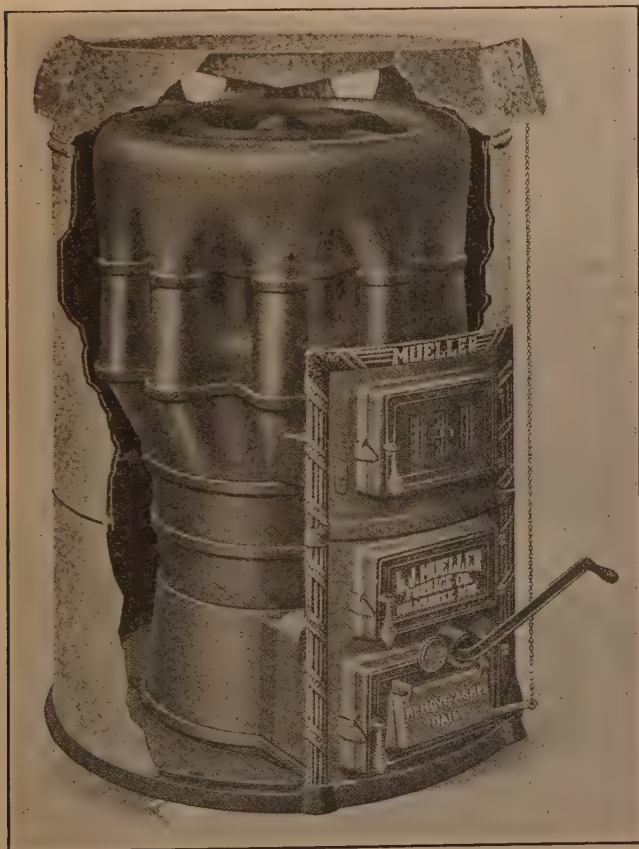
air is constantly being brought into the house, thus providing ventilation as well as heat.

So at this time we are concerned only with central heating plants, leaving the matter of individual stoves and fire places to another part of this chapter. The cost being the all-important consideration with many home builders, it is interesting to note that while the cost of heating plants varies in different parts of the country, in a general way it will be found that the hot-air types are least expensive. There are two kinds of hot-air systems, namely, the pipeless furnace and the regular hot-air furnace. The former, instead of making use of a number of risers going to various parts of the house, has a double register centrally placed in the house. The stove is surrounded by a double wall, so that the heated air rises through a central duct and register, circulates about the house and, upon becoming cold, drops down to the floor as it is crowded downward by the heated air which continues to rise. The cold air is then drawn down through the outer register which is connected with the outer duct of the stove, until it comes in contact with the hot stove walls which heat it and cause it to rise through the inner duct and up into the house. The same air is being used over and over again.

The pipeless system is, of course, simplicity itself as regards the furnace as well as the installation. The furnace is little more than a large stove with a double wall casing, while the installation calls for nothing more than the cutting of a large, square hole in the floor above, and placing the furnace below it. The regular hot-air system also is little more than a large stove with a single wall casing, but it requires a cold-air duct which runs to the outside of the house so as to bring in fresh air, as well as a number of risers leading to various parts of the house.

Steam heating follows the regular hot-air furnace

in point of cost. This kind of heat calls for a rather elaborate boiler, a single line of piping, and a num-



Typical hot-air furnace of modern design, broken away to show the internal construction.—(Courtesy L. J. Mueller Furnace Co.)

ber of radiators placed in the various parts of the house. The material, in this case, is considerably more costly than the previously-mentioned systems, while the installation is also much more costly.

Next comes hot-water heat, which calls for an elaborate boiler as well as a double line of piping to the various parts of the house, and radiators for the different rooms. Inasmuch as the hot-water heat is not as hot as steam, it is necessary to use larger radiators, which brings up the cost materially. Finally, we have the vapor system of heating, which is the most expensive kind of heat in general use.

According to The Architects' Small House Service Bureau, if a pipeless furnace costs \$150, a hot-air system would approximate \$250, a steam plant would cost \$350, and a hot-water or vapor system would amount to \$475 and over. These figures merely serve to establish the relative cost of the various systems.

UPKEEP AND REPAIR

It has been pointed out already that the first cost of the heating plant is by no means the only cost. Heating the home is an important item in the expenses of maintaining the home, and one which cannot be avoided, at least in localities that have cold winters. So we must consider the relative efficiency of different types of heating plants, since efficiency can be translated into tons of coal, and the latter can be translated again into dollars and cents of upkeep.

As a general rule, it is agreed that a hot-air furnace will burn from a fifth to two-fifths more fuel than a steam system. Hot water should save a tenth to a fifth, while a vapor system should consume at least a quarter less fuel than steam. Hence the higher initial cost of some heating systems is offset by the economy in operation.

HOT-AIR HEAT

Although it calls for the cheapest kind of heating plant available, hot-air heat has several advantages which are worth considering. First of all, it is said to be the most healthful kind of heat because fresh air is taken into the house through a fresh-air duct, warmed and easily humidified by means of a water pan before it ascends through the pipes to the rooms. Thus it is a ventilating system as well as a heating system, and persons accustomed to hot-air heating find it difficult to get along with steam or hot-water heat because of the marked change. Hot-air heat is a comfortable heat, sufficiently humidified to make it most effective. In this connection particular attention is called to the water pans of hot-air furnaces, which should always be kept clean and filled.

Then again, hot air is a quick heat. A good hot-air furnace will respond within a few minutes.

Thus in the spring and fall, when the mornings and evenings are apt to be chilly while the days remain too warm for a coal fire, the hot-air furnace may be operated for an hour or less with scraps of wood. It will immediately heat the house, drive out dampness, and take off the chill, with a minimum of bother. Then, too, if there are unusually warm days during the winter, the hot-air furnace can be made to respond immediately to



The drafts of the usual heating plant. To increase the fire and consequent heat, close check damper and feed-door damper, and open ash-pit damper. Reverse this process to reduce fire and heat.

the demand for less heat, by opening the feed door which cools down the fire, shutting off the ash pit draft damper, opening the check damper, and, if necessary, shutting off the risers.

There is virtually nothing that can go wrong with the usual hot-air furnace. It is simplicity itself. Furthermore, the worst that can happen to the hot-air furnace when it is left going while the home owner is absent for an entire day or even longer during the winter, is for the fire to go out, as contrasted with what could happen to a hot-water heating plant with its exposed piping filled with water.

Another advantage of hot-air heating is that the system occupies no space in the room which it heats. The plant no doubt requires more cellar space than hot-water heat or steam heat and the risers have a tendency to reduce the head room, but in the heated rooms it merely calls for a hole in the floor or in the wall.

So much for the good points of hot air. It also has its disadvantages. Perhaps the main disadvantage is the dust and dirt which usually goes with hot-air heating. Finely powdered ashes find their way into the risers and are circulated throughout the house, settling on furniture, walls, floors and elsewhere, much to the house-wife's dismay. Also, at times, coal gases escape through the registers to the rooms, although this may be avoided almost entirely by always keeping the smoke-pipe damper wide open, except when there is an excessive draft and the coals are all quite red.

Hot air works admirably during mild weather, but when the weather is quite cold and especially when there is considerable wind, hot air sometimes fails to perform at all. At such times the furnace must be kept going at full blast in order to maintain the heat. This is also true of steam, whereas with hot water the fire can be lowered and the system will nevertheless stay warm for several hours.

CORRECT INSTALLATION OF HOT-AIR HEAT

For the successful heating of the home by means of hot-air heat, the risers should receive due consideration. Hot air is light. It rises slowly. Therefore, the risers or pipes should have sufficient rise to allow the heated air to ascend without sharp turns and obstructions to overcome. It should have no resistance to overcome in reaching the rooms to be heated. The exposed pipes or risers in the cellar or basement should be covered with good air-cell covering. Risers covered with asbestos paper, as is so often the case, actually cause a heat loss of 20 per cent more than uncovered pipes.

While there is little to get out of order, as already stated, the hot-air plant requires repairs from time to time. The risers in time become rusted and must be replaced. Certain parts of the furnace become clogged up with ashes and must be cleaned out through the "clean out" door. To avoid the rusting tendency, it is wise to make a paper fire or wood fire in the furnace every so often when the furnace is not in constant use. A small blaze in the fire box sends a puff of warm air up through the pipes and dries them out.

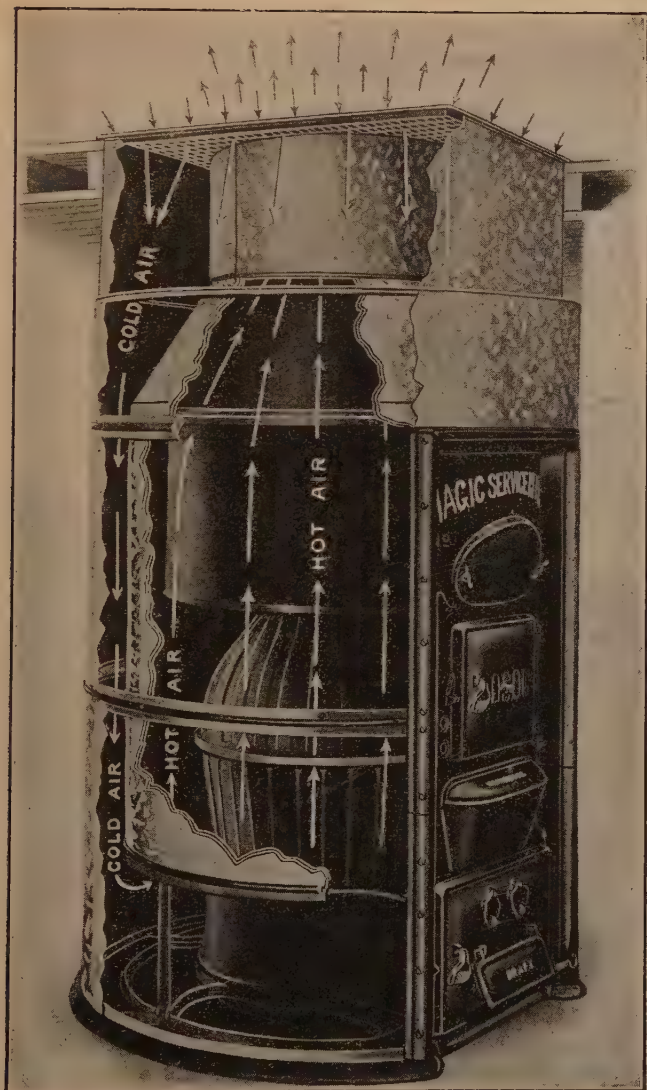
By now the theory of hot-air heating must be familiar to the reader. The cold air, taken in through the cold-air duct, comes in contact with the hot stove, is heated, and then rises up through the risers to the various parts of the house. That is the theory of the thing. In practice, things work out somewhat differently, at times, particularly during extremely cold weather. The warm air often has insufficient rising power to displace the cold air in the rooms above, with the consequence that warmth is not properly distributed. To the end of correcting this trouble and also economizing in fuel—it requires a considerable amount of fuel merely to overheat the air in order that it will

rise—there have been developed ingenious devices known as the furnacestat and the aerofan. These devices have to do with boosting the warm air up through the risers, irrespective of weather conditions.

The essential feature of this hot-air boosting system is the aerofan, which is a specially designed and economical fan motor but four inches in its widest diameter so that it will not interfere with the natural circulation of air. The motor and the propeller offer the minimum resistance to natural circulation when the fan is not in operation. The fan is mounted with universal connections so that its base may be located conveniently while the fan proper and the propeller are pointed into the stream of ascending air. Thus the fan can be counted upon to boost the warm air up through the risers, although it is usually placed in the cold-air duct. However, small aerofans may be placed in any riser in which air circulation must be boosted.

So far, so good. Now it is necessary to start the fan when the warm air fails to rise in the desired manner, and to shut off the fan when the warm air rises of its own accord in sufficient volume. To this end there has been developed a companion device, the furnacestat. This consists of an automatic switch operated by a thermostat, or temperature-operated member. The furnacestat is installed with the sensitive element projecting through the casing of the furnace into the warm-air chamber—usually as close to the top as practicable. Expanding or contracting with variations of temperature, this sensitive element actuates a snap switch located in the head of the device which stands out from the furnace to allow clearance for the wiring. This switch connects with the fan which stops and starts in direct response to changes in temperature.

In the fan circuit a switch is placed and connected



Typical pipeless heating plant, partly broken away to show internal construction and the circulation of air.—(Courtesy Somerville Stove Works.)

with the chain that opens and closes the draft damper. When the draft is opened this switch closes and turns on the current to the furnacestat, which automatically controls the fan so long as the draft is on and heat is required. But when the draft is closed this switch opens and cuts off the current from the furnacestat, which prevents the fan from running while the draft is closed and no heat is wanted. No manual supervision is required.

While the furnacestat and the aerofan are not claimed to be cure-alls for hot-air furnace troubles, they do help out materially in the average installation, and they do make all the difference between unsatisfactory results and very satisfactory results in instances where the hot-air installation makes use of risers with almost horizontal sections, sharp turns, very short and very long risers in combination, and so on.

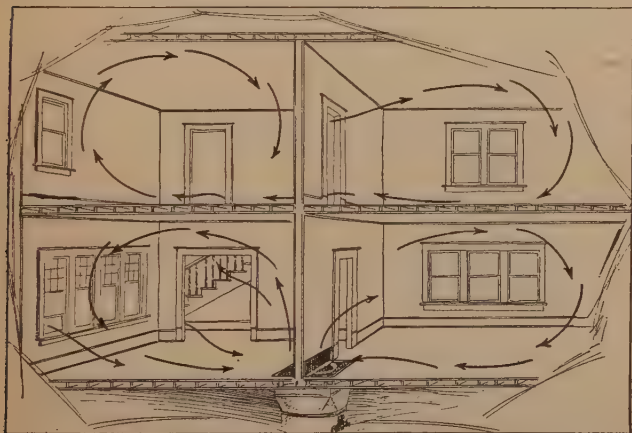
Architect Flagg in his small houses, described in another chapter, suggests the use of a hot-air heating plant. However, inasmuch as the basement is eliminated in the usual Flagg house, the hot-air system has to be equipped with forced air circulation, and in this connection the aerofan will be found most useful.

THE CASE FOR THE PIPELESS FURNACE

If the home is small, compact, and well insulated against the weather, particularly in the matter of sealing about door frames and window frames, a pipeless furnace may be employed to good advantage. Fortunately, the pipeless furnace works out quite nicely in the small, inexpensive bungalow where the item of expense is an all-important one. The pipeless furnace is simplicity itself, low in first cost, and readily installed at a minimum expense. It will burn either

coal or wood and there is nothing to get out of order.

The principle of the pipeless furnace has already been described. Suffice it to repeat here that cold air in the rooms is always nearest the floor. It is taken through separate openings which surround the larger register to the fire chamber in the furnace. Here it is heated and ascends through the one and only large register opening provided for heat distribution. This opening is usually in the center of the main floor. The



Diagrammatic explanation of the functioning of a pipeless heating plant, showing how the heated air rises, circulates throughout the house, sinks down to the heating plant, and is reheated for further circulation.

hot air rises to the ceiling, cools, falls to the floor and is again taken to the furnace for re-heating and re-circulation. Water pans in the furnace add moisture to the air.

In order to heat all rooms adequately with this type of heating system, all the room doors must be kept opened and registers placed in second story floors.

Indeed, this is one of the disadvantages of this type of heating plant. Often it is not feasible to keep all doors open, especially bedrooms and even the bathroom. Yet the moment the doors are closed the heated air is shut off and the temperature drops in the closed rooms. Grills or transoms can be placed in the room doors if desired, to overcome this difficulty in large part. Another disadvantage of the pipeless furnace heat is that the floors are often quite cold, which is somewhat disagreeable. Nevertheless, it is surprising how the heat is distributed. The farthestmost corners of a house will be found as well heated as the room in which the register is placed. The entire success or failure of a pipeless heating system depends on an open arrangement of rooms distributed about the centrally located register. And it is well, in this connection, to consult the manufacturer of a pipeless furnace as to the feasibility of pipeless heat before going ahead with the purchase and installation.

RADIATOR HEATING

The hot-air system and the pipeless system have the advantage of simplicity and also the fact that they do not take up space in the rooms to be heated. We now come to radiator heating, in which space is taken up in the rooms to be heated. There are three main types of radiator heat, namely, hot-water, steam, and vapor or vacuum. Each one requires a boiler and the best steam fitting available for proper installation.

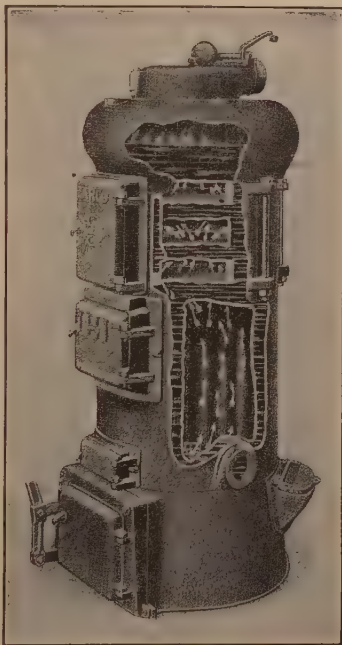
Steam is the least expensive to install. It requires either a single pipe from the boiler to the radiators and return, or two pipes, one for the supply and one for the return, of small size. Hot water requires return pipes, so that each radiator must be provided with two sets of pipes, one for the supply and one for the return, the pipes being of larger size than those used

for steam. Furthermore, hot-water heating installation requires more careful workmanship than steam. This means extra labor and materials for installation.

Steam is a satisfactory heat and is quite generally used in both large and small buildings. Because of the pressure behind steam heat, it can be forced to reach, distribute and maintain heat at great heights and distances. This is one reason why steam is favored for office buildings, apartments and large dwellings in general.

Some people complain about steam heating because radiators knock and sizzle. However, if the home builder insists upon well-made air valves and has them properly installed, and if the pipes are large enough with sufficient pitch, there should be no trouble with leaks, knocks, or noise, according to The Architects Small House Service Bureau. If, on the other hand, the home builder lessens his installation cost by substituting cheaper and inferior valves and equipment, he

is almost sure to have trouble. It pays to buy the best. The initial expense may be greater, but the up-



Typical steam boiler, partly broken away to show internal construction.—(Courtesy American Radiator Co.)

keep cost and repair bills will be less and the results more satisfactory.

A boiler in the home equipped with steam heat, generates steam which ascends through pipes to the radiators. It gives off heat, condenses in the radiators, and flows back usually by gravity to the boiler. It is again evaporated and completes the circuit once more, and so on.

The reason, as already explained, why steam installation is less expensive than hot water is because only a single circuit of pipe is required, whereas with hot water it is necessary to have a second series of piping called "returns" to allow the cool water to return to the boiler for reheating. Furthermore, steam is hotter than hot water and requires small radiators and smaller pipes. The number and the sizes of radiators required should be left to the architect or the contractor, if not to the manufacturer.

If the home builder wishes a heating system that is more readily controlled, less dirty than hot air, capable of more evenly distributed heat, and yet not as expensive as hot water, steam will fill the bill.

HOT-WATER HEAT—THE IDEAL HEAT

Hot-water heat is generally recognized as the most satisfactory kind of heat where expense is not the main consideration. It is highly popular today. Hot-water heat lends itself to perfect control of temperature. Weather conditions have little effect on its efficiency. It is a clean, comfortable heat, reaching every part of the house in which it has been properly installed.

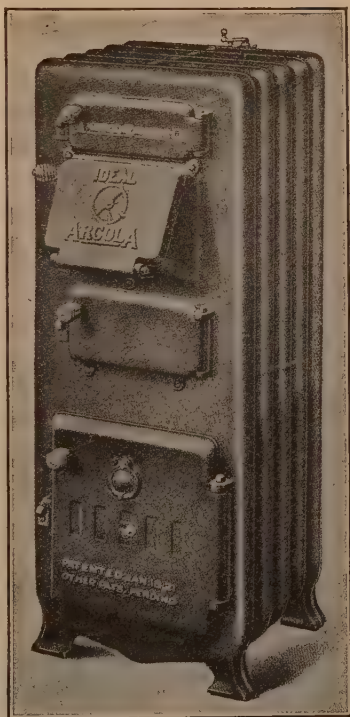
Hot-water heat operates in much the same manner as hot air. The water is first heated in the boiler. As it expands through the action of heat, it grows lighter and passes through the piping system to the

radiators. Here it cools as it imparts its heat, to the surrounding air, and is returned through a separate set of pipes to the boiler for re-heating and circulation. Once heated, hot water will remain so for a number of hours. If the fire should get low, the water in the hot-water system is still warm and will give off its heat for quite a while.

Ordinarily, hot-water plants are placed in the cellar or basement of the home. The boiler and the mains are below the floor. However, in cases where there is no cellar or basement, the boiler can be placed on the same floor as the rooms to be heated, and the mains which carry the heated water to the radiators can be placed on the ceiling. The water will pass

to the radiators and can be taken back to the boiler through pipes placed along the baseboard of the room.

If the home is small, there are available today small hotwater boilers that have the general appearance of a neat cabinet. These boilers are neatly enclosed and serve the double purpose of heater and radiator. A boiler of this kind can be placed in one of the rooms



Radiator-Boiler — small, compact hot-water heating plant for cellar-less home.—(Courtesy American Radiator Co.)

of the small house and will supply heat to other radiators. Such a small hot-water heating plant is particularly well adapted to homes without basements or those built on low, wet ground where excavation beneath the home is impractical. Even in the home with a basement, these plants are sometimes preferred because the boiler can be placed in the kitchen or other room, readily accessible to the housewife, thus avoiding the troublesome and trying task of going down into the cellar or basement to attend to the fire.

Vapor systems are practical in both large and small homes. They are a source of sure, constant heat in homes that cover considerable ground area with a large number of rooms. The principle underlying vapor heat is the removal of air from the radiators and piping system without permitting it again to enter the system during circulation.

In any radiator system, it is wise to place radiators along outside walls whenever possible and as near windows as possible. This will minimize the possibility of cold drafts and air reaching the floor.

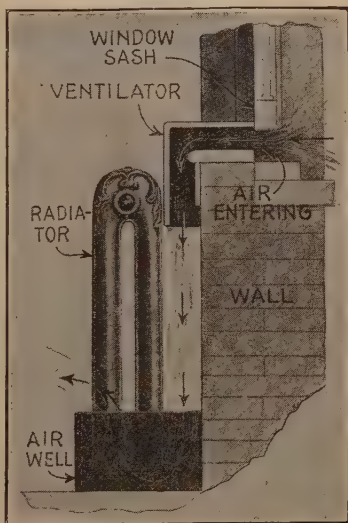
THE QUESTION OF FUELS

Fuels for house-heating purposes may be mentioned in the order of their desirability as follows: (1) Anthracite coal in sizes commonly known as buckwheat, pea, chestnut, stove, egg, and furnace; (2) gas-retort or metallurgical coke in pieces one-half inch and up to 3 inches through; (3) coal briquettes, 2 or 3 inches in diameter; (4) screen Pocahontas (semi-bituminous) coal, over one-quarter inch and up to 3 and 4 inches in diameter; (5) sized bituminous coal in pieces one-half to 3 inches across. Although a good grade of hard coal is generally considered to be preferable to any other fuel for house-heating furnaces, coke may often be found to be more satisfactory than the

hard coal obtainable. The smallest size of coke, known as No. 2 nut, running from one-half inch to 2 inches, frequently may be purchased at a price below that asked for the usual furnace sizes, because of the popular impression that it can not be burned successfully on ordinary furnace grates. Investigations have shown this size of coke to be very satisfactory for heating houses and stores. A larger size does not lie so closely and therefore frequently burns too fast, requiring more frequent firing. On the other hand, proper care will prevent this small sized coke from dropping through the grate bars to the ash pit.

As for the size of coal to use with any given heating plant, the house owner should consult the manufacturer of the heating plant or his coal dealer. The same may be said regarding coke.

With the common fuels other than coal or coke, the purchaser has little choice of quality except, perhaps, as to wood. Here the amount of heat per pound of dry wood is nearly the same no matter what kind of wood is considered, but as wood is usually sold by the cord measure and not by weight, it is important to know something about the relative weight per cord.



Ingenious scheme for ventilating and heating at one time, thus obtaining the advantages of heated-air heat without hot-air heat disadvantages.

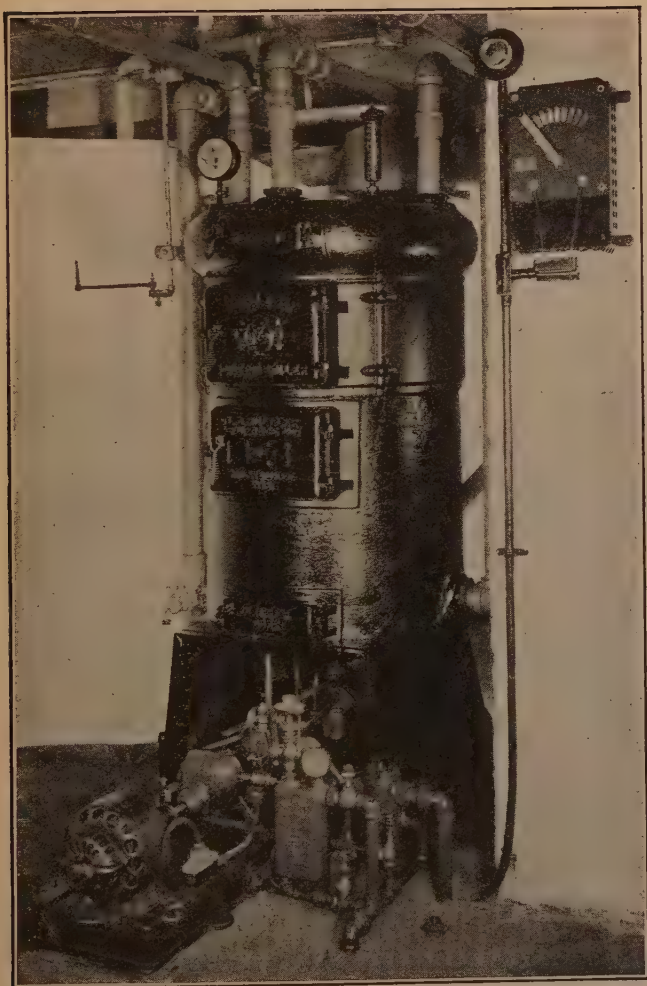
If the user will occasionally have a load of dry wood weighed, he can easily calculate approximately what is the most economical sort of wood for him to buy. This will be the wood of which he can get the greatest number of pounds per dollar, provided always that the wood is thoroughly dry when weighed.

Charcoal is sometimes used for fuel. The characteristics of the grades of charcoal sold for fuel vary according to the kinds of wood and the care used in their preparation. Since charcoal usually serves only as a kindling material or for fireplaces where it gives an attractive fire, size and convenience of handling are important characteristics. Charcoal fires, when used without a flue, are very liable to produce "furnace gas" containing the dangerous carbon monoxide, and fatal results have occurred from their use. An effective flue should always be provided.

HEATING WITH OIL

The usual coal fire is open to several objections, even admitting that the heat from coal is about all that could be desired. The first objection is the amount of care and labor which the coal fire entails. It must be supplied with fresh fuel from time to time, it must be shaken down and trimmed, and the ashes removed. The last-mentioned task is by no means pleasant. It is surprising how rapidly ashes accumulate, and when they are removed from the ash pit and placed in barrels or pails or boxes, the dust and dirt manage somehow to spread throughout the basement and, in the case of some types of hot-air and pipeless furnace heating systems, throughout the house. Still another problem is the removal of the ashes from the premises.

Continuing on the line of objections, we come to the high cost of coal, which makes the cost of heating with this fuel a serious matter. While there are heat-



Typical hot-water boiler equipped with a modern fuel-oil burner.—(Courtesy Hardinge Bros.)

ing plants that have automatic feeding devices, the usual boiler or furnace requires constant supervision lest the fire go out. Finally, the dust and dirt coincidental to the operation of a coal fire, together with the storage of the coal supply, makes the average cellar or basement unfit for any other use except to hold the heating plant, the supply of coal, and the ash barrels. Thus much space is wasted which might well be put to more profitable use, were the heating plant of a neater character.

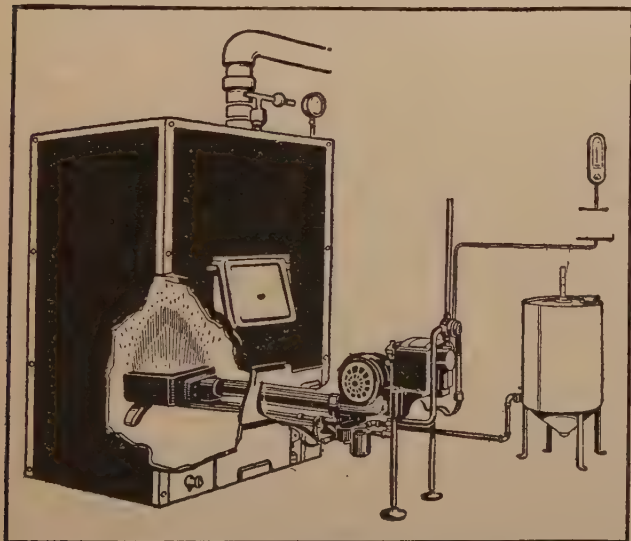
All these objections, and more particularly the high price of coal, have caused the development of the present-day oil burner which may be employed with practically any heating plant. Indeed, the oil burner is an accessory, and not a definite component of the usual heating plant, which means that it can be installed in any existing heating plant in place of the usual coal grate.

There are many types of oil burners now available, and the home builder or home owner who is interested in this matter should obtain the literature from the many manufacturers. The better kind of oil burner is a simple, automatic appliance that burns oil with a clean, sootless, odorless flame. It can be installed in any type of coal furnace by merely removing the grate bars, and it will continue month after month and year after year to render wonderful service and comfort.

The better kind of oil burner has an electric motor and a blower which atomizes the oil, a gas pilot light to ignite it and a positive automatic thermostat which starts and stops the burner, so that oil is used when heat is needed, thus maintaining an even temperature at all hours and in all kinds of weather. Such a burner utilizes every atom of its oil without waste and oil has a higher thermal value than coal. Oil is the clean, wasteless fuel. It requires no handling and can be poured into the supply tank directly from the oil

delivery truck without tracking mud and dirt into the house or destroying shrubbery or breaking basement windows.

The better kind of oil burner, unlike a coal fire, does not burn every hour of the day. It burns intermittently—only as heat is needed. If the house tempera-



How the fuel-oil burner is installed in a steam boiler, with no other change than the removal of the usual grate.—(Courtesy American Nokol Co.)

ture drops below the point at which the thermostat is set, the oil burner flame automatically begins to send heat throughout the house, and as soon as the temperature reaches the point indicated on the thermostat the flame immediately dwindles to a pin point, where it remains until the house temperature again drops below the desired point. Thus it goes all day in the oil-

burning home. If the weather suddenly turns warm, no oil is burned. If it turns cold, the oil burner automatically supplies all the heat that is needed.

The properly equipped oil-burning heating plant cannot be overheated or underheated because it is entirely automatic in its operation. The home owner need not depend on servants or any member of his family to look after the fire. There is no possibility of being without heat, and there is no unpleasant work, such as firing coal and removing ashes, to be done.

The usual oil-heating installation consists of a storage tank, generally of 1,000-gallon capacity for the average small home, a supply tank, an electric blower and gasifying mechanism, and the burner or combustion chamber. The storage tank is placed outside the building walls, with a convenient filler pipe and a feed line coming into the house. In some installations a supply tank of 100 gallons is placed in the basement, and it is from this tank that the oil heater derives its immediate fuel supply. The electric blower and gasifying mechanism prepares the fuel oil by breaking it up into small particles and mixing it with air, passing this mixture on to the combustion chamber where it is ignited to give a fire with virtually no soot or smoke.

THE USE OF GAS FOR HEATING

Perhaps the ideal heating plant arrangement is that brought about through the use of natural gas or artificial gas. The former is available in certain sections of the country. While in different districts natural gas is of different compositions, its principal constituent is always methane, or "marsh gas," which is a compound of carbon and hydrogen that has a very low lighting value for the open flame but a high heating value. Manufactured gas, on the other hand, is

usually made by the coal-gas, the carburetted-water-gas or the oil-gas process.

Either natural gas or manufactured gas can be used by means of a suitable burner directly in the usual heating plant fire pot, by removing the grate. When used in connection with a pilot light and a thermostat control, the gas burner has the same general advantages as the oil burner, in that it requires no attention whatsoever. What is more, there is no fuel to be handled, inasmuch as the fuel supply is drawn directly from the supply lines of the gas company. However, while the cost of natural gas is quite reasonable, that of manufactured gas is generally prohibitive when applied to the heating plant. The use of manufactured gas in this connection generally costs about three times as much as would coal for the same purpose. However, when it is remembered that there is no labor attached to the firing of the furnace or boiler and there are no ashes to be handled, the cost does not bulk up so hopelessly.

AUTOMATIC TEMPERATURE REGULATING DEVICES

There is a steadily-growing demand for automatic temperature regulation in the average home. Not only does the American family of today desire release from the serfdom imposed by the manually-operated heating plant, but there is a growing appreciation of the economy in fuel brought about through automatic regulation of combustion.

The simplest thing in the way of a labor saver is a remote control for the furnace dampers. This usually takes the form of chains which connect the furnace dampers with a wheel or lever control placed in some convenient room, so that the heat can be regulated without having to go down into the basement or cellar. Such a simple system, which can be installed at a low

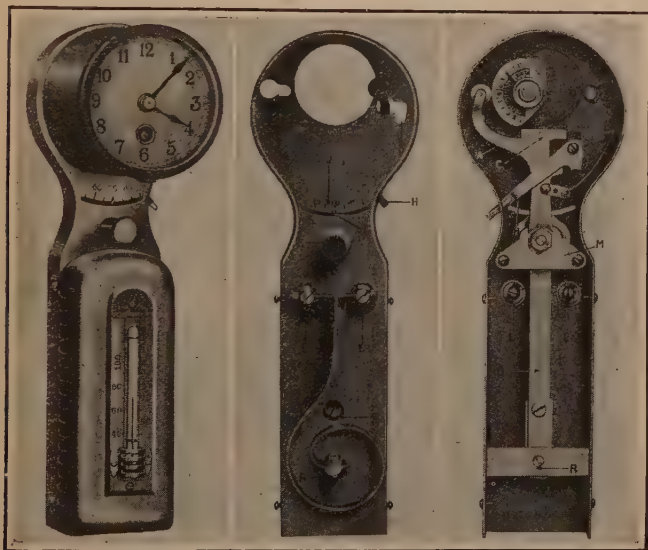
cost, saves a good many steps in the course of a winter, although it is not, strictly speaking, an automatic control. It is merely a remote control, and it is still necessary for someone to regulate the dampers according to the changing temperature.

Of late years there have appeared on the market several types of automatic temperature regulators which not only attend to the dampers of the usual heating plant, but which make for a marked economy in coal consumption in that they cause more or less combustion of fuel according to ever-changing temperature demands. The usual automatic temperature regulator automatically opens and closes the dampers of the heating plant, whether it be hot air, pipeless, hot water, vapor, steam, gas or oil, and at exactly the moment when the room temperature rises or falls one degree above or below the point required.

The usual automatic temperature regulator consists of two members—the thermostat and the motor. The thermostat is placed on an inside wall at some central location in the building, and controls the operation of the motor, which is located in the basement and connected to the heater dampers. The thermostat does the *thinking*, so to speak, while the motor does the *acting*, the two members being electrically connected. Thus the temperature of the home or building is kept uniform and steady, with a minimum fuel consumption. Automatic regulation also removes the possibility of fire, saves much labor and annoyance, keeps the whole house evenly heated, and therefore is more healthful. Just so long as fuel is available, the automatic temperature regulator goes on with its work, whether the occupants of the home are in or out.

The dampers are opened and closed, according to the dictates of the thermostat, by means of a powerful motor. The motor may be of the gravity, spring, or electric type. In the case of the gravity type, the

motive power is supplied by a weight, say of ten pounds, which will give from 20 to 25 operations on one winding, in the average basement. Two dry batteries or city lighting current, reduced through a special transformer, serve to trip the gravity motor. The spring type, on the other hand, is fitted with a spring of sufficient size and strength to operate the motor for



Thermostat for automatic heat control. Left view shows complete instrument. Center view shows thermostatic element. Right view shows clock-operated cam which regulates day-time and night-time operation.—(Courtesy Honeywell Heating Specialties Co.)

from one to two weeks. The winding indicator shows at a glance just how much reserve power the spring contains. The motor is tripped either by two standard dry cells or the city current reduced to 12 volts by a special transformer. Both the gravity and the

spring types are relatively inexpensive, and if they are wound up at regular intervals they will perform quite satisfactorily.

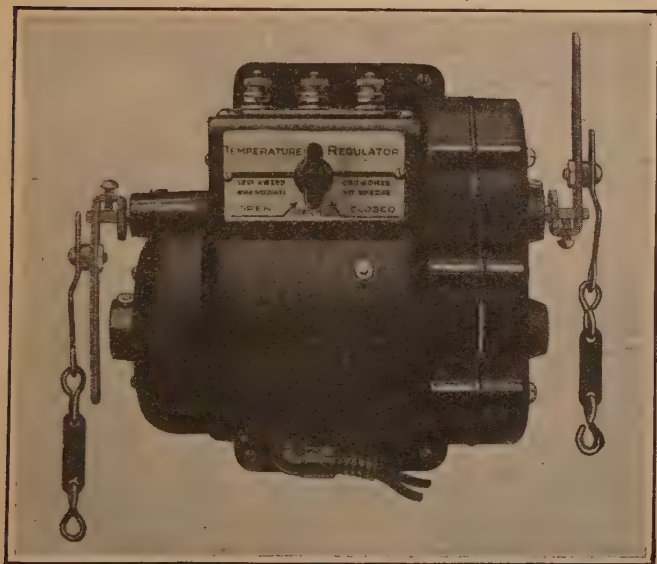
The ideal type is the electric motor, which requires no attention, except lubrication at the beginning of the cold season. The author has had considerable first-hand experience with the new Honeywell electric regulator motor, which is shown in one of the accompanying illustrations. This motor is remarkably simple and efficient and sufficiently powerful to lift one hundred pounds, yet it is noiseless in operation and the current consumption is negligible. It will open and close the heaviest dampers when used in connection with the burning of coal, or operate various kinds of valves, including oil, water, steam and gas, day in and day out, without attention of any kind.

In the case of alternating current operation, the Honeywell motor uses no transformer, no relay, no coils, no delicate contacts, and requires no adjustment. All parts are completely enclosed in a dust-and-oil-proof housing, yet all parts are readily accessible.

The regulator motor, whether it be of the gravity, spring or electric type, is mounted in some convenient place. The revolving arms of the motor are then connected to the drafts or controls of the heating plant by means of chains and wire, passing over pulleys, so that the motor may be made to do the work which would ordinarily call for manual operation.

THE THERMOSTAT AND ITS WORK

Now the device that does the *thinking* for the automatic temperature regulator system is the thermostat, which is located in any part of the house that is considered the "key" room, so far as the temperature for the whole house is concerned. Thus it would not

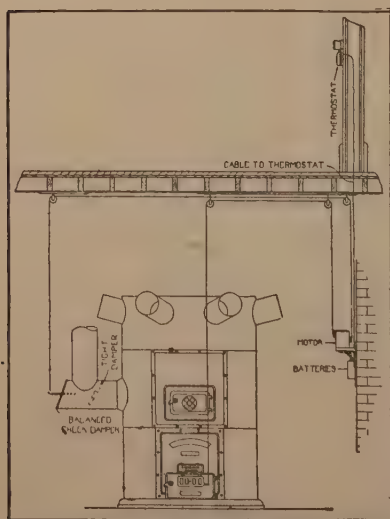


Electric motor for operating heating plant drafts or controls according to thermostat regulator in remote part of house. The revolving arms are connected with heating plant drafts or controls.—(Courtesy Honeywell Heating Specialties Co.)

be good judgment to place the thermostat in the front hallway of the home, for every time the door would be opened to the outside, the cold air would cause the thermostat to operate the dampers of the heating plant, even though the other rooms of the house might be quite warm. So the thermostat is placed in a room protected from cold drafts and, all around, typical of the temperature condition which is desired throughout the house.

The thermostat is a heat-operated device. The thermostatic blades are made from one continuous piece of very heavy laminated metal. The ends of the sensitive blades, as well as the contact screw points, are

made from platinum in one of the better types of thermostats. The thermostatic blades are so sensitive that a temperature change of one degree will cause the



Typical thermostat and spring motor installation for the automatic regulation of a hot-air heating plant.

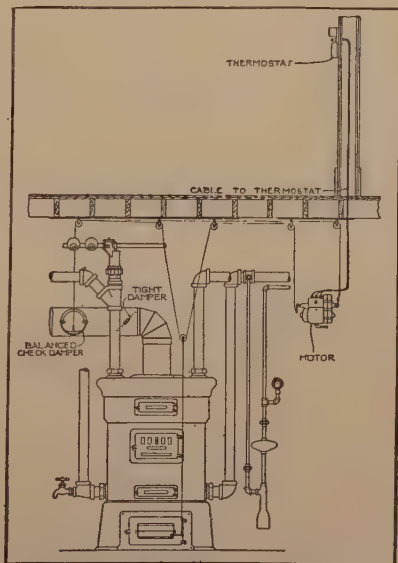
thermostat to operate the motor in the basement, but any temperature variance desired can be had. By turning an indicator on the front of the thermostat to any desired temperature, the thermostat will automatically open and close the heating plant drafts by means of the motor in the basement, to maintain that temperature. If the temperature rises above the desired point, the thermostat causes the check damper to open and the ash pit

draft damper to close, and vice versa, in the case of the usual coal-operated plant. Other means, also controlled by the thermostat, are employed for oil-burning, gas-burning, and special heating plants.

So much for the plain thermostat. However, automatic temperature control even goes one step further: by incorporating a clock movement in the thermostat mechanism, it becomes possible to maintain a given temperature during the greater part of the day, shutting down to a lower temperature during the night,

followed by an automatic resumption of the higher day-time temperature in the morning. The clock mechanism operates a cam mechanism which adjusts the thermostat for a lower temperature during certain hours of the twenty-four, to be followed by an automatic resumption of the day-time temperature long before the family gets up in the morning.

The writer has been using a Honeywell automatic thermostat and electric motor system for two winters, with excellent results. The clock mechanism is adjusted for a temperature of 70 degrees from six in the morning until eleven o'clock at night. The night temperature is set for 50 degrees, this type of thermostat permitting a definite temperature to be maintained during the night, instead of merely banking the fire and allowing the temperature to drop down to any temperature which conditions might bring about. If, for any reason, it becomes necessary to maintain the day-time temperature an hour or two longer at night, a little knob is manipulated, which throws the clock mechanism out of gear, thus maintain-



Thermostat and electric motor installation for the automatic regulation of a hot-water heating plant.

ing day-time temperature until the knob is again manipulated, bringing about night-time temperature. Furthermore, if a higher or lower temperature is desired, the thermostat can be instantly readjusted.

The thermostat control is one of those little refinements in the household that one can get along without until one has at least tried them out. Then they become indispensable, for their full value is at last thoroughly appreciated. The cold, dark winter mornings are robbed of their terror, for with the thermostat the family gets up in a nicely warmed house. All through the day not a thought is given to the furnace or boiler, except to see that it gets its full quota of coal. If the weather is exceptionally cold, the ashes are occasionally shaken down. At such times, the automatic temperature regulator is switched off, so as not to interfere with the stoking operations. If the weather is warm, a bed of ashes is allowed to accumulate. But the greater part of the worry and bother of heating plant operation is removed by the automatic temperature control, and one comes to look upon the thermostat as a faithful, ever-watchful, janitor. And the saving in fuel consumption ultimately pays for the thermostat installation, if the matter must be looked at from the dollars-and-cents angle.

SMOKEPIPE DAMPER REGULATOR

One of the several ingenious devices recently introduced for improving the operation of heating plants and introducing automatic means to replace manual means as far as possible, is the smokepipe damper regulator. This device limits and regulates the rate of combustion in any type of stove or heater. Located in the smokepipe between the heating unit and the chimney, it guards against excessive stack temperatures which are wasteful and dangerous.

As the fire is increased in intensity, the temperature of the gases passing up the chimney increases. As the temperature rises, the thermostatic element in the smokepipe regulator expands and closes the smokepipe in proportion to the temperature of the gases. As the natural draft is reduced, the rate of combustion in the fire pot is retarded because of insufficient draft and therefore the fire is checked and the smokepipe cools. As it cools, the thermostatic element contracts and the damper opens, allowing natural draft conditions to be re-established.

Whenever more heat is developed than the heater can absorb, instead of the surplus passing out through the chimney, the smoke-damper regulator takes control of the smokepipe and automatically, day or night, checks the fire to the point where no more heat is generated than can be absorbed in the heater. Thus

this device is a perfect regulator on stoves and small heaters, as well as a dependable limiting device to prevent dangerous overheating of boiler and furnace smokepipes.

There are numerous other devices which serve to



Smoke-pipe damper regulator which operates by means of a thermostatic element.—(Courtesy Honeywell Heating Specialties Co.)

increase the efficiency and convenience of any type of heating plant, and the progressive home owners will do well to look into all these devices.

COAL STOVES, OIL STOVES, GAS STOVES, AND ELECTRIC HEATERS

So much for central heating plants and their controlling devices. The central heating plant idea is of relatively recent times. Not so long ago houses were heated by means of fire-places, which eventually gave way to the more practical coal stoves. Gas stoves and oil stoves followed, and today we have the electric heater, as well.

There are times when stoves are desired, either as a matter of economy or because of the lack of a basement or other architectural considerations. Excellent coal stoves are available, and it is surprising how well a small stove will heat not only the room in which it is placed, but adjoining rooms at the same time.

Quite recently there has appeared on the market a variation of the pipeless furnace made in the form of a very attractive cabinet, which may be placed in any room without detracting from the general neatness of the room. Indeed, it has the general lines of a cabinet phonograph. This stove takes in the cold air of the room, heats it, and then circulates the heated air throughout the room until it has given off its heat and returns to the stove to be heated and re-circulated. Such a stove is an improvement over the simple stove.

Oil stoves now available are quite satisfactory, as compared with the smoky, inefficient and even unsafe oil stoves of not so many years ago. Oil stoves give off considerable heat and may be used for heating a small room, although their main function should be to boost up the temperature of some far-off corner of the house, rather than to supply the primary heat, so to speak.

Gas stoves are excellent heaters, but are subject to several criticisms. For one thing, they often leak gas, so that they may become detrimental to the health of the occupants of rooms in which they are used, and even deadly if, for any reason, the flames should be extinguished and the gas supply turned on subsequently. In fact, the gas heater has lost much of its former popularity, its place being taken by the oil heater and the electric heater.

As for the electric heater, it has its place. It is an excellent form of heat for small rooms, such as the bedroom or the cold bathroom. To-day the great majority of electric heaters are in the form of a deep parabolic copper reflector, which throws out the heat in a narrow beam. Unfortunately, the heat is quite localized, but this is necessary with a minimum consumption of current.

Electric heaters without the directive reflector are also available but are quite expensive in operation, hence the popularity of the reflector type. When it comes to heating any appreciable sized room with electricity, the cost is prohibitive.



Pipeless hot-air heater which takes the place of the usual stove. Because of its attractive design, it does not detract from the appearance of any room, being finished in imitation mahogany or other wood.

AND THE FIREPLACE

The fireplace—that is something which comes within the scope of this chapter dealing with heating of the house. But as a matter of fact, is the fireplace not more in the nature of a very desirable ornament and producer of cheer rather than a heating device? Of course!

At best, the fireplace does not produce much real heat. It throws out quite a little heat which may be felt by those sitting in front of it, but it leaves the rest of the room quite cold and uncomfortable, unless a less handsome and more practical form of heating plant is employed, which is generally the case.

Yet a fireplace adds much to any home. No home can claim to be complete without a fireplace. A house is more salable with a fireplace than without. A fireplace dresses up any room in which it may be installed. It is a natural gathering place for the home folks.

The accompanying illustration shows the business of building a chimney and a fireplace. The chimney should have two flues, one for the fireplace and one for the heating plant. Note that the chimney stands practically independent of the framing around it. The following points are essential to the construction of a successful fireplace and chimney:

First—a good footing. This should have a projection of at least 8 inches and a depth of 12 inches. Do not use the foundation wall as one of the walls of the ash pit.

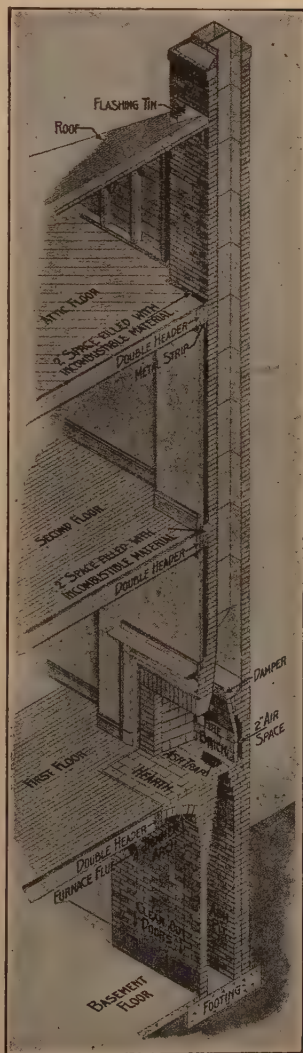
Second—the width, height and depth of the fireplace opening should be of proper proportion to each other and to the size of the room. A fireplace opening about 3 feet wide and 2 feet high is large enough for the average living room. The depth should never be less than 16, nor more than 24 inches. The height, except for very large fireplaces, should not be over 2 feet 6

inches and should never exceed the width. The area of the cross-section of the smoke flue should never be less than one-tenth to one-ninth the area of the fire-place opening.

Third—it should reflect heat into the room. This is accomplished by making the back two-thirds the width of the front, and by sloping the back and splaying the sides, as shown in the drawing. The sides and back of the fireplace should be built of good fire brick set in fire clay.

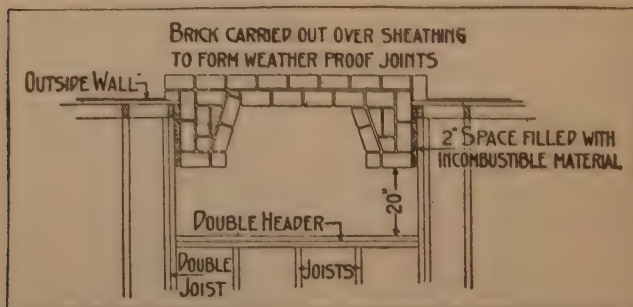
Fourth—the throat and damper should be of proper size and correctly located. A fireplace may be built without an iron throat and damper, but using one is a pretty safe guarantee of proper size and form. The iron throat and damper should extend over the entire width of the fireplace.

Fifth—a properly constructed smoke shelf and



Ideal construction of a fireplace and a chimney.—Courtesy Weyerhaeuser Forest Products).

smoke chamber should be provided. The smoke shelf is formed by setting back the brickwork at the top of the throat. It should be the full width of the throat and not less than four inches wide. Eight to 12 inches is still better. Its purpose is to deflect the down draft. The smoke chamber is the space from the top of the throat to the bottom of the flue. This space is necessary to hold the smoke temporarily when



Fireplace partly exposed on outside of building, showing best kind of construction.—(Courtesy Weyerhaeuser Forest Products.)

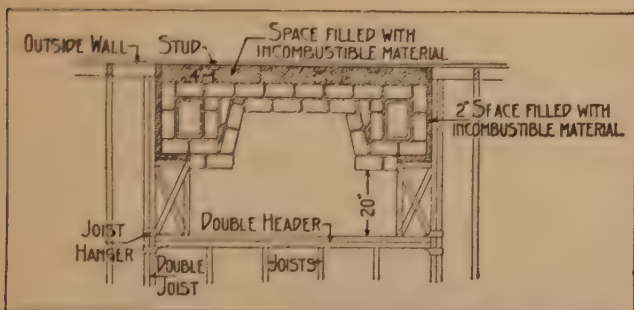
a gust of wind across the top of the chimney momentarily cuts off the draft. Otherwise, the smoke would be forced into the room. The walls of the smoke chamber should be plastered smooth.

Sixth—the chimney should be carried high enough above the house to ensure a good draft.

BUILDING ABOUT THE FIREPLACE

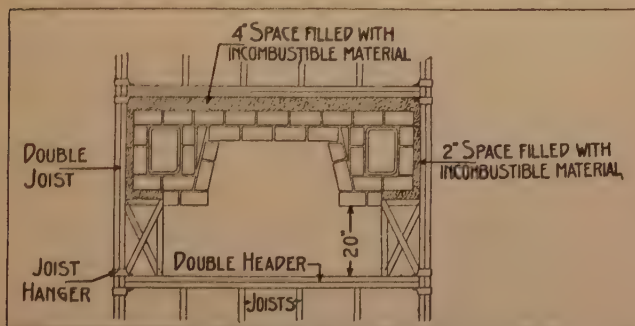
The accompanying drawings depict the proper methods of floor framing around the fireplaces built under the several varying conditions.

The principle applied in each case is the same. All



Fireplace built against outside wall but not exposed. Note the liberal use of heat insulation.—(Courtesy Weyerhaeuser Forest Products.)

framing members on the sides of the fireplace should be at least 2 inches away from brick or masonry wall, unless protected by 8 or more inches of brickwork, or 12 inches or more of masonry. The intervening space should be filled with incombustible material such as mineral wool, concrete or mortar.



Fireplace inside of house having wood floor framing on all sides.—(Courtesy Weyerhaeuser Forest Products.)

The framing at back should be at least four inches away, and the intervening space at each floor filled with incombustible material. The back should be at least 8 inches thick and lined with fire brick.

The head-joists or beam supporting the trimmer arch in front of a fireplace should be not less than 20 inches from the chimney breast. The hearth should be not less than 4 inches thick and should extend at least 20 inches in front of the fireplace. The woodwork around the fireplace should be not nearer than 8 inches at the sides of the opening and 12 inches at the top.

The incombustible material used for filling between the framing members and the brickwork should be supported by strips of sheet metal or metal lath set into brickwork and nailed to the joists with a buckle joint to allow for the settling of the chimney.

CHAPTER XVI.

WIRING THE HOME AND THE QUESTION OF ILLUMINATION

THE modern home is not complete unless it is wired for electric lights and electrical appliances of various kinds. Even in the rural home, far removed from a public electric light and power company's supply lines, the modern tendency is to discard the oil lamp in favor of a private electric lighting plant. In this respect, we again find the property owner in the city, town or sizable village more fortunately situated than the property owner in the rural districts, inasmuch as the former need only wire his home and connect with the supply line of the local electric light company, while the latter must wire his home and, in addition, supply an electrical power plant.

WHY NOT COMPLETE WIRING IN THE FIRST PLACE?

The two purposes which electricity serves in the home—illumination and the operation of appliances and labor-saving devices—calls for proper and complete wiring. The proper development of electricity in any

house will go a long way towards making it a real home.

Now the time to make sure that the home will be completely wired is when the plans are being drawn up. All architects include the wiring layout in the working plans of any building. The home builder should make it a point to go over the working plans with the electrical symbols in mind, so as to visualize the electrical layout. Changes can be readily made on working plans, but once the wiring is finished and the walls are being plastered, changes and additions are expensive.

The essential wiring is that which provides for illumination in every part of the house. Thus the simplest and least expensive wiring job is one that provides a lighting fixture in each room of the house. For added convenience, it may be desirable to have switches. Thus there should be a switch at the head of the cellar stairs, so as to enable the occupants to turn the cellar lights on and off from the top of the stairs, instead of having to go down into the dark cellar and fumble about for the lights. Then, too, there should be a switch for the porch light, said switch being placed inside the house, somewhere near the front door. Again, there should be a switch for the attic lights, if the attic is wired. Convenience demands that switches be installed for controlling the lights in the living room, dining room, and other rooms, although, to be sure, switches add somewhat to the cost of wiring.

Some attention should be paid to the matter of three-way switches. These switches serve to control the same light from two widely separated points. Thus one three-way switch is installed at the bottom of the stairs and another at the head of the stairs, both controlling the hall lights. Therefore, if one wishes to go upstairs, the downstairs switch is pushed, lighting the hall lights. Reaching upstairs, the upstairs switch is

pushed, turning off the hall lights. In this manner full control of the hall lights is had from either switch. Three-way switches may be installed in any part of the house where this convenience is desirable.

Aside from the question of fixtures, it is well to bear in mind the future use of lamps. The modern home calls for subdued lighting, which is brought about through the use of pretty lamps. Instead of running unsightly wires to the fixtures, connections for such lamps should be made with baseboard outlets. While the home is being wired is the time to install a sufficient number of outlets so as to take care of any lamps that may be used in the decorative scheme of the home.

Again, the modern home makes use of numerous electrical appliances. There is the electric iron, which is used in the laundry or the kitchen. There are the electric toaster, percolator, grill, and table stove which are used in the dining room or the breakfast room. There is the vacuum cleaner which is carried from one room to another in cleaning the home. There are the electric pad, electric heater, electric curling iron and electric baby's bottle warmer used in the bedroom. The electric heater and electric curling iron, as well as the electric hot-water immersion heater may also be used in the bath room. For all these appliances it is necessary to install convenient outlets, otherwise awkward connections must be made with the usual fixtures.

Hence the necessity of making the wiring complete at the time the home is being wired. It is so much simpler, more satisfactory, and less costly at that time.

THE HIDDEN DETAILS OF WIRING

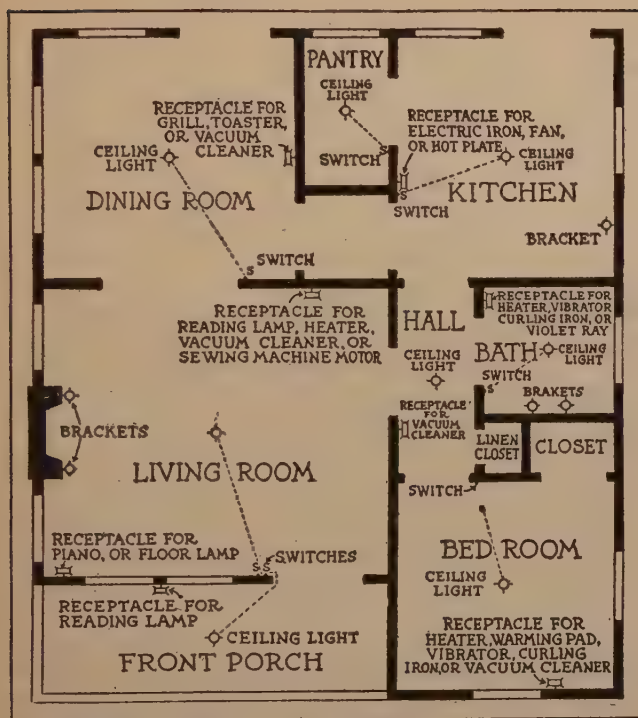
Time was when electric wiring manifested itself in the form of wooden molding which contained the wires, or in the form of exposed insulated wires supported at regular intervals by porcelain cleats or porcelain knobs.

Today, however, wiring is of the concealed order, running between ceiling and floor above, and up and down between walls, without a trace except where it is brought to a fixture, switch, or convenient outlet.

The home builder never sees the most important part of the wiring job—the part that is hidden behind the walls and under the floors. It cannot be inspected before buying. So the question of electric wiring comes down to a question of faith in the responsibility, experience, skill and good repute of the electrical contractor who is to install the wiring. Also, aside from the skill and trustworthiness of the contractor himself, there is the question of the materials employed; for here, once more, the matter of good materials is as important as good work. Only when the contractor has demonstrated that he possesses these qualifications and that all his material is invariably of the best has he earned the right to the home builder's confidence.

There is another reason why a good contractor should be selected, even though it may mean a little more for the job. The reputation that the contractor has gained is at stake when he does the home builder's job, and it is staked on the latter's satisfaction with its results. The contractor whose workmanship is unskillful and whose material is flimsy has nothing to lose by one more unskillful and flimsy installation. The contractor of good repute has everything to lose. Obviously, then, the careful homebuilder will be guided not so much by a low bid as by a high reputation.

Then, too, the home builder is buying more than wiring when he chooses a contractor whose past record has proved his high qualifications; he is buying something far more valuable and yet that costs him no more. It is experience; and it is to the contractor's own interest that the home builder receive the benefit of this experience. Complete wiring installation by an electrical contractor thus qualified and using the



Electric light wiring for small bungalow as indicated on the plans. Note symbols for fixtures, switches and receptacles.—
(Courtesy Montgomery Ward Company)

best material and workmanship costs about five per cent of the total building cost. This value is a continuing asset, and the home builder will find that it contributes a far higher percentage to his enjoyment of the new home.

All of which is said and said at length here in order to impress the inexperienced home builder with the im-

portance of the electric wiring of the home. In these days when almost everyone believes himself to be an electrician, there is always grave danger of the home builder either endeavoring to do the wiring himself, or relegating this highly important task to some jack-of-all-trades.

THE DETAILS OF WIRING

There is not much choice in the matter of house wiring, especially if the wiring is to be concealed. The most commonly employed wiring is with flexible cable, known as BX. This flexible cable contains two or three wires, properly insulated and wrapped with a protective sheathing of twisted metal. It can be run between floors and between walls without any considerations aside from mechanical ones, since the wires are amply insulated and protected. As an added electrical precaution, the metal sheathing is grounded—connected with a water pipe. Sometimes, but very rarely in the usual home construction, the wiring is installed in rigid conduits—iron pipes which are threaded and joined together to form a continuous piping, not unlike a plumbing job. However, in the usual home installation the only piece of conduit work is that placed on the outside of the house and serves to bring down the electric service wires from the level of the cornice down into the basement.

The flexible cable or BX is installed in the home under construction just before the lathing is done. It is held in place by means of straps, nailed or screwed to joists, studs, and so on. Where the cable must pass through a joist, beam, wall bridging or other obstruction, a neat hole is bored with brace and bit. Indeed, the facility with which BX can be run to every part of a house has made it highly popular not only in the wiring of new houses, but also in wiring old dwellings.

At such points where fixtures, switches and base-board outlets are to be installed, fixture blocks or proper outlet boxes are installed. The outlet boxes are pressed iron boxes of various sizes and shapes according to the purpose to be served, and have round depressions in their sides which merely need to be tapped with a hammer to produce a round hole. The BX is passed through these holes, and the metal sheathing is removed for a sufficient distance to expose the enclosed wires which are then available for connections in the outlet box. The fixture blocks are round iron pieces with round holes through which the BX can be passed and clamped in place. A threaded stud is provided in the center of the fixture block, which takes the insulated coupling that connects up with the fixture. This method and others are employed for supporting fixtures, and after the BX wires and the fixture wires have been connected and soldered or firmly clamped together, as well as taped, the job is covered up with a decorative cover known as the canopy.

So when the wiring is being done the BX is brought to the various outlet boxes and fixture blocks, and the wire connections are left in them, ready for future use. This "roughing in" process precedes lathing and plastering, and the outlet boxes and fixture blocks must be mounted in such a manner that they will fit into the plastered walls and the ceiling. Once the walls and ceiling are finished, the fixture blocks and outlet boxes are provided with fixtures, switches, or outlet parts and plates so as to finish the work.

The wiring starts with the outside connection with the service wires. If the electric light company's wires are underground, as in the case of large cities, the service wires are naturally brought directly into the cellar. If they are overhead, then they are generally brought overhead from the nearest electric light pole to a pair of insulators on the side of the house, often

as high as the eaves of the roof or the cornice. A neater arrangement, although somewhat costly, is to tap the electric light company's wires at the pole, run the service wires down through a pipe and conduit under the ground, directly into the cellar of the house. In this manner there are no unsightly wires to take away from the appearance of the house. Thence the wiring goes to the basement, where it passes through the service switch and fuses, the meter, and the house switch and fuses. If the wiring is at all extensive, there may be a distributing panel which distributes the incoming current to various circuits. Ordinarily, the small house has two circuits, say one for upstairs and one for downstairs, in order that the distributing system may not be entirely put out of commission, leaving the house in total darkness or without any use of electricity for power purposes, in the event of a blown-out fuse. From the distributing board or house switch, the wiring leads to all parts of the house.

There are definite rules applying to wiring of all kinds. In most cities the municipal code provides for inspection of all wiring done so as to insure its meeting the fire underwriters' standards. In some localities the electric light company will not turn on the service unless the job has been inspected by the proper authorities and a certificate of approval has been issued. But whether the locality enforces electric wiring inspections or not, the home owner should see to it that his wiring is in full accord with the fire underwriters' standards. The reliable contractor will see to it purely as a routine matter. In the specifications there should be included the phrase "All work shall meet the requirements of the National Electric Code," and the contractor should be required to furnish a certificate of approval of the entire installation as issued by the Board of Fire Underwriters having jurisdiction in the community, before his work is considered completed.

If special electrical equipment is to be employed, it is necessary to provide special wiring. Anything in the way of an electrical appliance that draws less than 660 watts may be connected with the usual socket or baseboard receptacle. However, an electric range, electric hot water heater of the instantaneous type or the boiler water-circulating type, and other appliances



Electric wiring serves for other purposes than illumination in the modern home. Here are a few of the electric appliances in everyday use.—(Courtesy New York Edison Co.)

drawing upwards of 1,000 watts require special and heavy wiring. Furthermore, most electric lighting companies have special rates for such electrical appliances, and it is well to take up the matter with the local electric light company at the time the house is being wired. If a special rate prevails, then a special

circuit with a special meter should be installed to take advantage of the lower current rate.

WIRING THE OLD HOUSE

The introduction of flexible cable or BX has simplified the task of rewiring the old home. No longer is it necessary to resort to the ugly exposed wiring of the cleat or knob kind, or even of the wooden molding kind. With very little fuss and dirt the old home is wired with the maximum dispatch and minimum cost. The clever contractor cuts holes here and there in the walls and floors, and snakes through the BX from room to room and from floor to floor. Sometimes a bit of flooring must be raised, or the baseboard must be removed; but everything is eventually put back in place and there is no sign of anything having been disturbed. Indeed, the layman is pleasantly surprised to note how readily an old house can be wired by modern methods.

THE FIXTURES FOR THE HOME

After the wiring is installed, the home builder or home renovator must purchase the necessary fixtures. This is a question of pocketbook, taste, and good sense. If the pocketbook permits, the home-owner had best go to one of the better class fixture manufacturers or dealers, for he is certain to get fixtures of lasting satisfaction. Unfortunately, the fixture business is one which lends itself to much sham and misrepresentation. The demand for cheap fixtures has caused the less scrupulous fixture manufacturers to turn out poor fixtures which do not last. What is supposed to be a heavy brass casting turns out, in time, to be nothing more than a cheap lead casting, brass plated. What was supposed to be a piece of turned brass proves to be a cheap punching. Cheap fixtures are made of thin

metal, poorly soldered together, and soon go to pieces, despite their original attractive and sturdy appearance. And so it goes. Here again, it pays to go in for less quantity and more quality. Is it not possible to buy part of the fixtures at a time? The wiring may be entirely installed at the time the house is being constructed, but the outlet boxes and fixture blocks can be provided with covers and painted over, and left that way until such future time when the home owner feels enabled to purchase the desired fixtures. One manufacturer has worked out a type of outlet box which is provided with an attractive brass plate or cover. Any desired fixture, whether it be a ceiling fixture or a wall fixture, can be fastened quite readily to such an outlet box and removed at will. This flexibility is very desirable at all times.

There are various kinds of light for the home, such as:

Direct light, in which the rays from a lamp are reflected in one general direction, usually downward, by means of a dense shade of glass, metal, or silk, for example, a reading lamp.

Semi-direct light, in which a lamp is equipped with a translucent reflector which permits some of the rays to pass through upward, yet reflects the majority of the rays downward. For example, pendant lamps with glass reflectors.

Indirect light, which may be considered the opposite of direct. Here the lamp is equipped with an opaque or partially opaque bowl reflector which directs the rays upward, to be reflected back by a white ceiling. The main advantage of this system of lighting is that it eliminates sharp shadows.

Semi-indirect light, which may be considered the opposite of semi-direct. For example, a lamp in a translucent bowl reflector, which allows some of the rays to pass through below, but reflects the majority

HOME ILLUMINATION

Types of fixtures, height from floor, and lamp size for various rooms of the home as recommended by illumination authorities.

LIVING-ROOM AND SUN-ROOM			DINING-ROOM		
Unit	Recommended Height	Lamp Size	Unit	Recommended Height	Lamp Size
	Not less than 75 inches from floor.	50-watt, diffusing lamp.		24 inches clearance between dome and table top.	75 or 100-watt lamp or Daylight lamp.
	Not less than 75 inches above floor.	50 or 75-watt diffusing lamps.		24 inches clearance between dome and table top.	75 or 100-watt lamp or Daylight lamp.
	Not less than 75 inches from floor.	100 or 150-watt lamp		Approximately 30 inches clearance above table top.	75-watt Daylight lamp in center dome, 15 or 25-watt all-frosted lamps in candles.
	On mantel—height according to taste.	15-watt all-frosted lamp.		36 inches clearance between bottom of shades and table top.	25 to 50-watt all-frosted or 50-watt diffusing lamps.
	Usually 6 feet from floor.	15-watt all-frosted lamp		45 inches clearance between bottom of shades and table top.	25 or 40-watt all-frosted lamps.
HALLS				36 inches clearance between bottom of shades and table top.	50-watt diffusing lamps in bowl and pendants.
	Not less than 75 inches from floor.	25-watt all-frosted or 50-watt diffusing lamp.		For dining table not over 14 inches high.	25-watt all-frosted lamp.
	Close to ceiling.	25 or 40-watt clear lamp.		On buffet—height according to taste.	15-watt all-frosted lamp.

HOME ILLUMINATION

Types of fixtures, height from floor, and lamp size for various rooms of the home, as recommended by illumination experts.

BEDROOM			BATHROOM		
Unit	Recommended Height	Lamp Size	Unit	Recommended Height	Lamp Size
	Not less than 75 inches from floor.	100 or 150-watt lamp.		Light center 5½ feet above floor—one on each side of mirror.	50 - watt diffusing lamps.
	Not less than 75 inches from floor.	50 or 75-watt diffusing lamps.	KITCHEN		
	Not less than 75 inches from floor.	25 to 40-watt all-frosted lamps or 50 - watt diffusing lamps.		At ceiling.	100-watt clear or 150-watt "daylight" lamp.
	Light center 5½ feet above floor—one on each side of mirror.	50 - watt diffusing lamps.		At ceiling.	100-watt clear or 150-watt "daylight" lamp.
	Light center 5½ feet above floor—one on each side of mirror.	50 - watt diffusing lamps.		Not less than 75 inches clearance above floor.	100-watt clear or 150-watt "daylight" lamp.
	Light center 10 to 12 inches above table top.	25 or 40-watt all-frosted lamp.		Supplementary fixture—wall bracket or pendant—at sink, stove, etc.	50 - watt diffusing lamp.
	Light center 24 inches above table top.	25 or 40-watt all-frosted lamp.	LAUNDRY AND BASEMENT		
	Clamped to head of bed for reading.	50 - watt diffusing lamp.		As close to the ceiling as possible.	100-watt clear or 150-watt "daylight" lamp.
				For laundry, close to ceiling. For work-bench, 7 feet from floor.	100 - watt Bowl-Enameled or 150-watt bowl—frosted "daylight" lamp.
				At ceiling.	50 - watt diffusing lamp.
			GARAGE		
				Usually not less than 75 inches clearance above floor for work-bench and engine.	100, 150 or 200-watt Bowl Enameled lamp.
				Hand - lamp on drop cord.	50-watt Mini Type lamp.

upward to be reflected back by the white ceiling.

These various kinds of light should be studied with a view to their application in the home. The accompanying charts give a general idea of various types of fixtures for different parts of the home. As to what kind of light to use, this is largely a matter of taste. Too much light as well as too little, should be avoided. A "soft" light of sufficient strength to afford easy vision without fatigue to the eyes, is the ideal illumination, according to illumination authorities. Pleasing local illumination may be obtained by means of lamps, properly shaded so that no bright light reaches the eyes. Such local illumination makes it unnecessary to flood the entire room with a burst of harsh light. Furthermore, local illumination, especially with attractive silk-covered lamps or parchment-shade lamps, gives the room a most attractive appearance. It has been said that more can be done with properly controlled lighting than with any other factor in making a room attractive.

CHAPTER XVII.

SOME LABOR-SAVING AND BUILT-IN FEATURES FOR THE MODERN HOME

IN planning the home it is well to give some thought to the work of the housewife. After all, a home is, to some extent, a workshop, in that family life calls for a certain daily routine involving more or less labor. And in order to make that labor as light as possible, it is well to introduce labor-saving features wherever possible, so that the home may be ideal in every way.

Then again, there are certain built-in features which are part and parcel of the home itself. Thus in the small home there may be need for the dining alcove, built-in buffets, dish closets, disappearing beds, and so on. So in this chapter we deal with all these built-in features which are components of the house and not so much additional furniture.

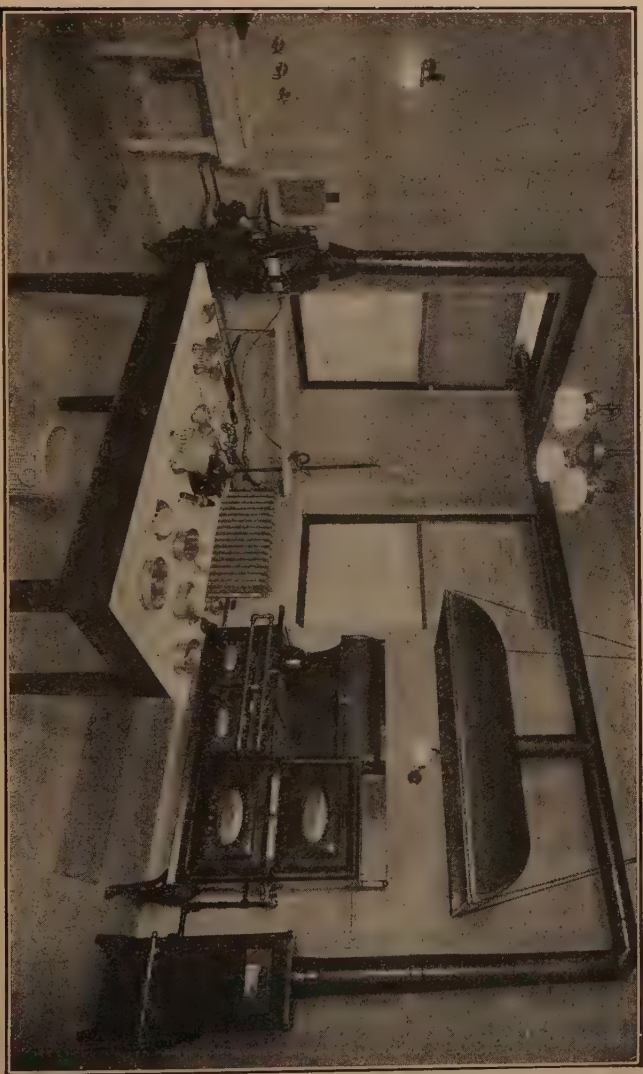
It has been estimated by authorities that seventy per cent of the average housewife's day is spent in and about the kitchen. Hence the kitchen is the logical starting point in the consideration of labor-saving devices.

PLANNING THE EFFICIENT KITCHEN

Nothing speeds up housework more, gives greater freedom, saves labor, steps, and lessens fatigue, than a well planned, adequately lighted and properly ventilated small kitchen, according to The Architect's Small House Service Bureau. Every housewife loves a bright, sunny, cheerful kitchen. She deserves this kind of kitchen. But she also needs one that minimizes every motion and every step.

The general tendency in present-day house plans is to make the kitchen small but compact. The modern kitchen is planned in a way that provides the utmost in step and labor economy as well as efficiency in house-keeping. With the exception of a number of home plans in which the kitchen is deliberately made large in order to permit eating in the same room, the usual kitchen is as small as practical without sacrificing a single kitchen fixture that ensures time, labor and step saving. Even in the combination eating and kitchen arrangements, it will be noted that the fixtures, ice box, food cupboards, stove, work table, sink and so on are placed to minimize steps and labor. Indeed, the old notion that a kitchen had to be a luxuriously large room is passing. A small, compact kitchen, well ventilated, with abundant light, where steps are "routed" and tools grouped, makes kitchen work not only less fatiguing but promotes health and happiness.

Probably no one feature of the old-fashioned kitchen caused the housewife to take so many unnecessary steps as the separate detached pantry. The new idea of "routing" steps, grouping tools and locating the essential kitchen fixtures—sink, table, range, cupboards, ice box, ironing board, broom closet, windows, lights—is a saving that runs up into thousands of hours and thousands of miles for American housewives each year.



A modern kitchen, equipped with a gas stove, a gas water heater, a gas grill, ironing board, kitchen table, porcelain sink with drain board. Special provisions have been made for heat and fumes.—(Scene—the American photo.)

What is meant by "routing" steps, grouping tools and fixtures? Let us explain with a graphic example:

A domestic science expert questioned hundreds of women who were doing their own housework. She wanted to find out how much time they spent in the laundry, preparing meals, dishwashing, sweeping and cleaning. She counted steps by means of a pedometer and tape measure. She approached the problem scientifically and as a result secured some highly interesting and helpful statistics about waste time and labor.

One experiment proved that a housewife in a poorly arranged kitchen walked 105 needless miles each year while preparing three meals a day!

It is quite impossible to plan a model kitchen adaptable to every home. Every housewife must work out a plan for equipment according to the size and needs of her family. Yet there are certain well established things that can be suggested that will help lighten kitchen work, save steps, labor and time.

In small homes, where the mistress of the house does her own housework, it has been found that the most satisfactory kitchen is slightly oblong. Every well planned kitchen should be an effective working unit. There should be a systematic, well studied sequence or "route" through which the housewife travels in preparing, serving, and clearing away a meal. Considering the use and purpose of essential kitchen equipment, it has been found that the following sequence provides a maximum time and labor-saving arrangement—ice box, kitchen cabinet, stove, work table to dining room.

Following the meal the steps or sequence should be from dining room to work table or counter for soiled dishes, sink, drain board, china closet. This "routing" is so arranged that work proceeds from right to left, leaving the dishes after drying in or near the dining room. In other words, the clearing away of a meal should go on from and return to the dining room in

direction opposite to the movements of the hands of a clock.

Detached pantries, food closets and butler's pantries are poor investments in a small home. They occupy valuable space and require needless steps and labor. The old-time kitchen used to have a large detached pantry, sometimes two and three. The housewife today does not store away, except in the country, large quantities of provisions and food supplies. The telephone and quick-delivery grocery has done away with the need for large storage pantries.

Cupboards are now placed in the kitchen itself, only a few feet away from work table, or built over and under the table proper. These built-in cupboards store non-perishable supplies and are easily accessible without "retracing steps" to and from a detached pantry. In a small home without maid service, the butlers' pantry is unnecessary. Its place is taken by sets of shelves near the sink, where dishes are placed as soon as washed and dried. Frequently, attractive built-in china cabinets in the dining room provide convenient and easy storage for dishes.

The grouping of tools is one of the chief points of the well-known kitchen efficiency idea. This means that a utensil or device should be permanently located where it is most frequently used and where it is easily reached when needed. This is not possible with the detached pantry or even the big kitchen closet which so often serves as a "catch all." Suppose the kitchen closet or the pantry is 15 feet away from the mixing table—the housekeeper must walk "to and fro" for spoons, knives, ladles, etc. If the kitchen is compact and provided with built-in closet, cupboards and shelves, it is possible to keep tools and groceries near the work table, spices and seasoning close at hand, pots and pans near the stove, egg beaters, paring knives,

mixing spoons in a drawer or hung from a shelf where they can be easily picked up.

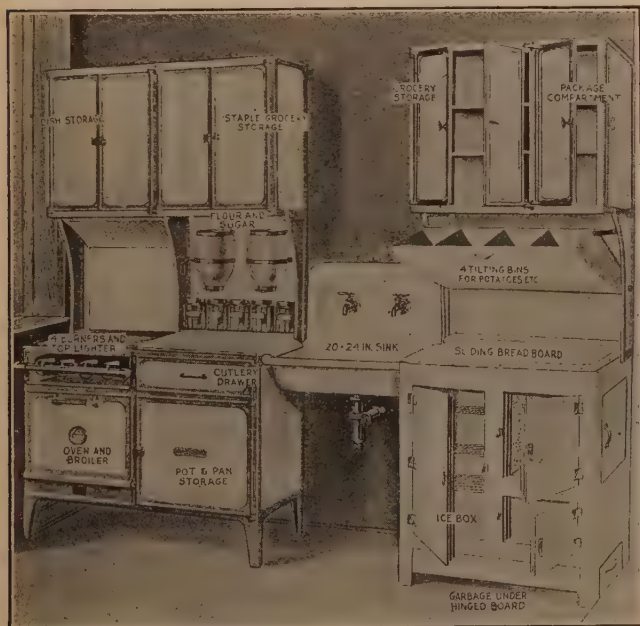
It is worth while to point out the need of having plenty of shelves of the right depth and height. A graded arrangement of narrow shelves with but one row of articles on each shelf, is a most efficient plan. This is preferable to having shelves all the same distance apart. Package goods can be accommodated on shelves six inches deep. For glass jars containing dry groceries, spices, etc., a four-inch shelf is proper. For glasses, cups and small dishes, six inches will allow a double row; eight inches for plates and most china-ware.

Many housekeepers prefer closed doors on cabinets and closets. Some domestic science experts say that, because of the cleanliness of modern fuels, open shelving is preferable to closed cabinets. Open shelves without doors mean less time required in opening and shutting doors, less expense for interior finish and more storage room.

Dishwashing can be made more agreeable by improving the condition under which the dishes are washed. Very often the sink is set too low for the housekeeper. She must stoop over when she uses it, which means backache and fatigue. Again, the sink is often placed in a dark, poorly ventilated corner, or there is not enough drainage space, or it is so shallow that the water slops over. Thirty-four to thirty-six inches from the floor, measuring from the top of the rim to the floor, is a good height for the sink. Two drain boards speed up dishwashing surprisingly. An excellent location for the sink is in the center of one wall, with a set of small windows above to allow plenty of light and air. It is well, too, to provide a lighting fixture near the sink, so that the housekeeper is not obliged to work in her own shadow.

There are available today neat kitchen cabinets

which may be installed in any kitchen. These cabinets combine the functions of the dish closet, the grocery closet, the pots and pans closet, and the work table. Such a cabinet may be placed in any kitchen and serves to make the work of the housekeeper much easier and



Attractive kitchen furniture arranged in a compact form for economizing space, especially in the small modern kitchen. (Scientific American photo.)

more pleasant. Indeed, sitting on a special kitchen stool, the housewife can proceed to make a cake or prepare food of any kind with a minimum of effort.

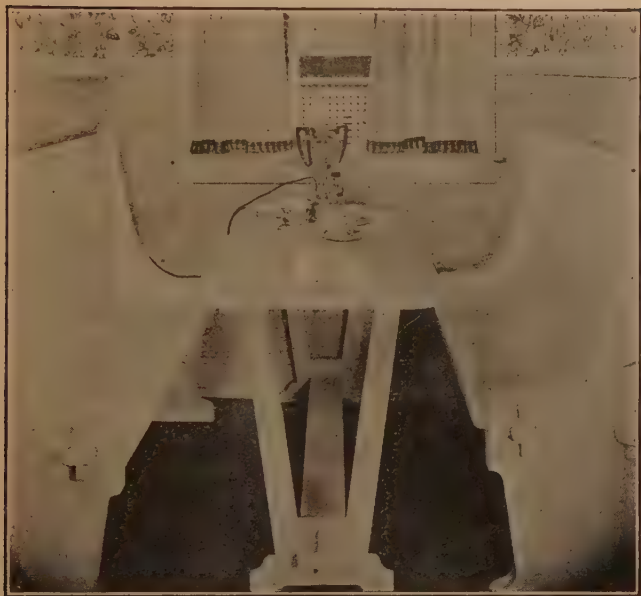
Also, there are available today other kitchen furni-

ture, such as a combination broom and linen closet, the disappearing ironing board, the pantry units and upper units, a sink unit to be placed above the sink for the storage of brushes, mops, soap, and other sink accessories, and so on. These various pieces of furniture can be combined so as to provide an excellent kitchen equipment, centralizing many functions to simplify the work and reduce steps.

Then there is the question of the ice box. This is generally a piece of furniture rather than a built-in feature. It may be placed in any convenient part of the kitchen. If desired, the ice box can be arranged for outside icing, which means that the ice box is provided with an opening at the rear which joins up with a hole cut into the wall and made accessible through an outside door, so that the ice man can place ice into the ice box without having to enter the house. In cold weather the outside door is left open, and no ice is required.

It pays to buy a good ice box. Unfortunately, ice boxes are bought largely on the basis of appearance. The average housewife fails to realize that the ice box is something more than an attractive piece of kitchen furniture. It is a chest insulated against heat. This insulation can be good or poor—good in the case of a properly constructed ice box, and poor and even very poor in a cheap ice box. Upon the excellence of the insulation depends the economical operation of the ice box. With poor insulation the ice melts fast and furiously, so that the owner eventually must find it quite unprofitable.

The most modern idea as regards ice boxes is the electrically-operated refrigerator. In this refrigerator the usual cake of ice is dispensed with, and instead the owner consumes electric current for driving a small brine pump. A thermostatic control maintains an even low temperature in the refrigerator at all times, and



Breakfast nook or dining alcove which, in many small modern homes, takes the place of the dining room.—(Scientific American photo.)

the pump operates only when the temperature tends to rise above the temperature set.

A rear vestibule or entry is a desirable feature for the usual kitchen. It provides a place for the children's toys, bicycles, baby carriages, and such things. It permits the delivery of ice, milk and groceries without tracking up the kitchen. The ice box can also be placed in the rear entry. In cold climates the rear entry has the further advantage of keeping drafts away from the kitchen.

THE BREAKFAST NOOK AND DINING ALCOVE

A feature that has been growing in popularity is the breakfast nook or dining alcove. In appearance the breakfast nook or dining alcove, whichever you wish to call it, suggests a double pew or two settees facing each other with a narrow table between them. Its origin is probably Dutch, but it is adapted to any modern kitchen or can be slipped between the living room and the kitchen. If the seats have hinged covers, there will be additional storage space for linens. The alcove can be furnished and decorated in such a way as to be a picturesque addition to the small home. It permits the housekeeper to serve meals with fewer steps because it is so close to the kitchen. While the dining alcove fulfills the purpose of the dining room, it does not take up the same amount of space. The room taken up by a dining room, which is at most used only three or four hours a day, is added to more important rooms.

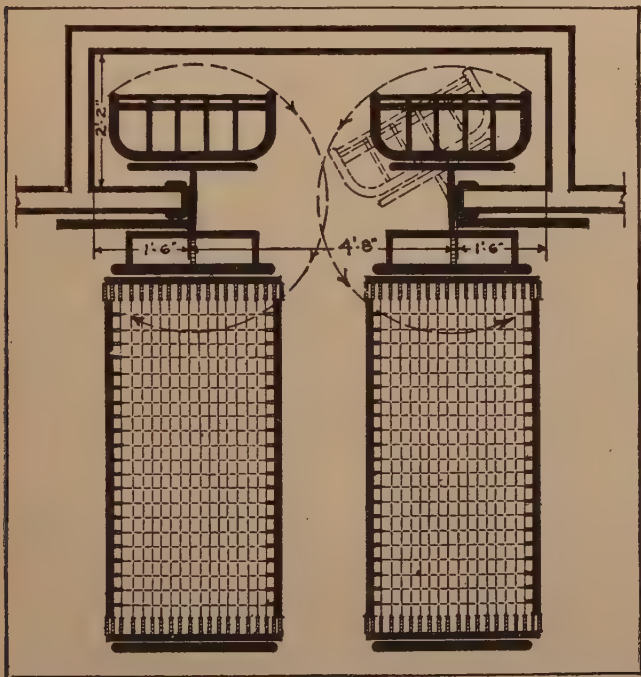
BOOKCASES, MEDICINE CABINET, BUILT-IN BUFFET

There are many things that can be built-in at the time the house is under construction, or even as an after-thought, although the latter procedure is generally more expensive. Thus there can be built-in bookcases on each side of the fireplace or forming part of an arch motif.

In the dining room there may be a built-in buffet, set flush with the wall if desired, by having this built-in feature in a bay extension. Built-in china closets can be placed in suitable places.

Built-in furniture saves room in the small house. Of late years there have appeared ingenious disappearing beds which may be employed in the small house so as to save space. These beds are stored in a space not

much larger than the usual cupboard, out of the way and out of sight behind a door. Thus a room is available during the day as a living room, a den, a dining room, a nursery. At night, however, the cupboard is



Disappearing twin beds which, during the day, fold up and swing around into a small closet, out of sight. Note the dimensions.—(Courtesy Murphy Bed Co.)

opened, the bed is swung out and down, all made up and ready for use. Thus any room can be made to function as two rooms—a day-time room and a bedroom.

In the upstairs hall may be placed linen closets and even a linen chute which serves to convey soiled laundry down to a hamper in the basement. In the bathroom there is the built-in medicine chest, rather than the medicine cabinet which is bought as an afterthought and hung on the wall after the fashion of a picture frame.

All these features and many others serve to make the home a comfortable and efficient home. Here the home builder will do well to consult the lady of the house, if he has failed to consult her about other phases of home building. For after all, it is the lady of the house who must maintain and operate the home, once it is completed and in full working order. To this end, the home owner will do well to provide his wife with an electric vacuum cleaner, an electric washing machine, an electric iron, and other labor-saving devices which make housekeeping more of a pleasant occupation and less of a drudge.

CHAPTER XVIII.

THE SETTING FOR THE HOME: MAKING THE MOST OF THE LAND

THE setting for the home—the approach, the driveway, the flower beds, the lawn, the vegetable garden, the garage and other features of the general surroundings—may make all the difference between a most attractive property and an unattractive property. Indeed, the home may be a masterpiece in every respect, only to be handicapped at the last moment by a hit-or-miss arrangement of the grounds. So, after the many problems of home building have been solved and the home proper is a closed chapter, it is well to devote a little thought and some action to the setting for the home. Thus, and only thus, can the ideal home be realized; for the surroundings are a very necessary part of any home.

The cost of making the grounds attractive need not be great. Fortunately, this phase of home making is quite flexible. The home owner may do much of the work himself, or, if he prefers, he may relegate the task to a landscape gardener. The home owner may

have the entire work done at one time, or he may do it bit by bit. However that may be, it is a fact that every dollar wisely invested in the planting of the home grounds will pay dividends year after year, not only in the added pleasure afforded by the home but also in the resale value of the property.

THE NEED FOR A PLANTING PLAN

Of course there is no fixed rule about the arrangement of the home grounds. How can there be, when every plot has its own peculiarities and when tastes vary so widely? Nevertheless, there should be some sort of plan made for the planting of the home grounds, after a study of the size and location of the property, the type and character of the home, the local available hardy plants, trees and shrubs, the character of the sub-soil, and the exposure. The plan should take into consideration the paths, driveway, location of garage, space for drying clothes, vegetable garden, and other details. Even though the entire plan may not be realized overnight, it serves as a definite guide in doing the work bit by bit and ensuring harmonious and pleasing results in the future.

To properly lay out your planting scheme, get a large piece of cross-section or plotting paper, which can be obtained at any stationery store, particularly those carrying drawing materials. Adopt a scale of a certain even number of squares to the foot, that will permit all the ground that is to be planted, to be shown on one piece of paper. Locate the street or road at the extreme bottom, then place by your adopted scale, the house, outbuildings, etc., and any trees or other natural features that may exist, according to their actual location from measurements, and then set to work locating your largest shrubs. Consider your color scheme and place the smaller shrubs, beds, borders, etc., mark-

ing the characteristic color for each, so that harmony may exist and the early and late flowering varieties will be distributed. You will find that thus located to scale, you can very readily visualize your planting and the laying out and staking will be much simplified.

In New England and New York States and correspondingly, it will undoubtedly be found most advantageous to plant in the fall with a good mulch of manure or straw for protection. Shrubs are delivered in the fall in a dormant state and if well and firmly planted, the working of the frost out of the ground in the spring settles the soil around the roots and greatly helps even the most careful planting. Your shrub is then ready to start growing with the first run of sap. Spring planting must necessarily be delayed till the ground is fit to work *after* the frost is out, so fall planting will have the advantage by several weeks.

The foregoing also applies to trees. If you are fortunate enough to have matured trees on your land, locate your house with respect to them and plant so that eventually the whole layout will have symmetry. The natural desire for quick results often leads one to plant too closely, then in a few years it is found that the trees have not room to grow. If you must have a showing quickly, plant fifteen feet apart with the purpose of cutting out every other tree later on, and locate the ones you expect to remove so that those remaining will be where you want them.

Often one is able to find maples and elms growing in waste land of a suitable size, which can readily be transplanted. When the leaves have fallen, dig a circular trench the width of a shovel completely around the tree about two feet from the trunk, going down at least fourteen inches. Then work under from this as far as possible. Now tip the tree over and with an axe cut the anchor root—which goes straight from the

trunk into the ground—as far down as you can strike. Leave as much of a ball of earth on the roots as you can handle to roll the tree out of the hole. With the ball resting on its edge, tip your wheel-barrow over and close up under the ball. Get around back of the ball and tip tree, ball and wheel-barrow to an upright position. In this manner you can load twice the weight you can lift.

The hole where the tree is to go should be dug at least a foot deeper than the thickness of the ball of earth on the tree, then fill in with leaves and earth to the proper depth. Cut off cleanly every root that has been severed or bruised. Cut the top back severely leaving four or five pruned branches to spread symmetrically. Fill in around the ball as much earth as you can tamp well under and then with a pickaxe break down and loosen up the outside wall, so that the hole will not be a well to collect water and drown out your tree. Soak well with water and keep watering at least once a week, allowing hose with water just barely turned on, to lie near the trunk, so that the water will penetrate to the roots, but be careful not to swamp the tree. This is worse than not watering it at all. Place guys in at least three directions, being sure that one is directly into the prevailing wind. Select large stakes and drive well in.

To obtain a smooth velvety lawn is quite a trick, but it can be done by the Home-Owner himself, with some care and a bit of hard work. You will need to hire a team only for the plowing and harrowing.

After removing all stone, brush, remains of building materials, etc., cover generously with fine decomposed manure, cow-dung preferred, and plow under in the fall to a depth of at least six inches. Let the land lie in the furrow over winter and the first day the soil shows dry on top, harrow with a team. Drive in rows of stakes running from the house in all directions at regular intervals of ten feet and run your

line along each row. Now cross line in circles round the house as you find the stakes and with your eye you can adjust till you get a proper sweep. Don't try to get too much regularity, but follow more or less the natural trend of the slope. Your stakes and lines are only to guide you so that there will not be humps or unsightly hollows in your lawn.

Begin at the house and following a line of stakes, use a wooden field rake so that you will dig out the weeds, sticks and stones, with least effort, grading to your lines as much as possible. Throw the accumulation into a wheel-barrow as you go along. Don't try to drag it in piles. After you have covered the whole lawn, take the regular iron rake and level to any nicety you may desire. Pull up your stakes and sight over the lawn as a whole. You will find there still much to do, filling here and leveling there.

Select a grade of lawn seed according to the soil, shade etc., any of the big Seedman will be glad to send you information as to the proper seed to use.

In sowing the seed, choose a calm day—it is utterly impossible to do an even job if a breeze is blowing. Take a small quantity in the fore palm of the hand between the thumb and first two fingers, closing the third and fourth fingers to form a cup. Cast in a swinging motion, right to left about eighteen inches from the ground, over the first finger, palm up, gradually opening up the fingers from first to fourth as the swing is completed. Sow a section at a time (it may be necessary to cover some spots you have missed) and rake that in before sowing more. A little experience will enable you to spread the seed evenly—this is most important.

When the seed is sown, throw over it all a few grains of clean seed oats, which will sprout quickly and form shade for the tender young grass. Rake over once, firmly and carefully. Do not attempt to do any leveling at this point. The first few strokes of the rake

will cover the seed, but if you make too many strokes, you will work some of the seed to the top again. When the grass has a good start and before the oats head out, cut them down and rake away so that they will not take strength from the soil. Do not be in a hurry to cut your new lawn. Many a good planting job has been ruined by early cutting and the subsequent burning out by the sun. While the seed is germinating the ground must not be allowed to dry out, but on the other hand excessive sprinkling will uncover a quantity of seed that is very near the top of the soil. Keep the grass well watered, in fact it is essential that it never gets dried out. Water sparingly but frequently, after sun-down with a very fine spray, for remember the tender young roots are near the surface and can easily be washed out or burned. If you flood the ground, it will pack down and the sun will bake it to a crust, so that the grass will not have a chance. A year of consistent and discriminating care will give a fine, hardy lawn the second year, as your reward.

The second year you should add some enrichment, preferably pulverized sheep manure, which is readily obtained through any feed dealer. This should be done at least every other year to provide the essentials for vigorous growth.

Landscape gardening is an art. A landscape gardener can take the same house, trees, shrubs, flowers, paths, drives, and other features, and arrange them on the same piece of land so as to make a most attractive ensemble. Unfortunately, the small home owner is usually not in a position to hire the services of a landscape gardener and must therefore be satisfied to handle this work as best he can. To this end, he should consult the local nursery man and florist, who can give much helpful advice as to the selection of desirable shrubbery and flowers and even trees, and their most attractive setting about the property. Furthermore, ideas can be obtained by studying the landscape treat-

ment of other properties. All the while, it should be borne in mind that the large piece of property presents a simpler landscape gardening problem than the small property, and that the type of house has an important bearing on the landscape gardening treatment. Thus the surroundings of the California bungalow may be entirely unsuited for northern climatic and topographical conditions. The semi-tropical plants and foliage of the South cannot withstand the severe northern winters. The formal treatment of an Italian villa is not suited to the informal and rugged gardening demanded by a Rocky Mountain chalet. And so it goes.

In advising home builders on the problem of the home grounds, The Architects' Small House Service Bureau has set down a few fundamental home gardening facts—some real helps which may serve as guide posts to successful landscaping—which are quoted here. The simplest way and the most direct to make clear the home gardening principles is to list them as a series of “don’ts” or “what to avoid in home gardening.” In this way they will serve as danger signals.

HOME GARDENING “DON’TS”

Don’t plant without a plan. It will cost you less in the long run. Your home will be more beautiful, your planting permanent, your house and lot more valuable. Don’t make the mistake of waiting until after your home is built before planning and planting. It is important not only to locate your house properly on the lot, but you should plan the walks, garden, borders, etc., before the house foundations are in and immovable.

Don’t forget to observe nature’s way of arranging shrubs, trees and flowers. In the woods you seldom find trees growing in straight lines, stiff and formal. Study the margins and outlines of woods and thickets.

You will notice indentations, bays and openings which give you beautiful pictures and vistas.

Don't overlook the soft edges, strong, yet harmonious contrasts which nature provides so abundantly.

Don't permit your planting to obstruct the sunlight and ventilation of your home.

Don't needlessly cut and prune trees. A good tree on your building site may be the key to a successful planting plan. A good tree, ten years old, is worth many dollars. Keep it and care for it.

Don't plant flower beds in the middle of a lawn. It makes the lawn appear "jumpy". A broad, unbroken expanse of well kept lawn is as beautiful in its way as the finest rug.

Don't forget that successful home gardening aims to tie the house and landscape into a complete and beautiful picture.

Think of your yard as an out-door room. A decorator does not begin by first providing something for the center of the room. He uses the walls, doors, windows and other architectural features as the basis for his scheme of decoration.

Treat your yard as you would a room. Shrubbery and flowers, being considered ornaments and not furniture, look best when they serve against the house and along the boundary line. Shrubbery and vines about a house tie it to the ground and soften the edges.

Windows should not be shaded. The blank and open spaces of the house are best suited for the planting of shrubbery and flowers.

Planting next to a walk or property line should never impede travel. Make the approach to your home easy and direct. Accent your walk with proper shrubs.

Don't forget that flowers pass quickly, whereas, shrubs and hardy trees live on constantly.

Remember that it isn't considered good taste to place red flowers against a red brick house. Contrasting col-

ors give more pleasing results. A flower box or border placed in front of shrubbery displays the flowers to good advantage. If the flowers must be neglected, the result will not be apparent.

It is best to put flowers, whether annual, perennial or bulbous, in borders rather than formal gardens.

When you transplant trees, shrubs, bushes, be sure that you cut them back sufficiently to permit them to absorb and take in nourishment quickly. Because shrubs and trees are delivered to you with long, frayed roots just as they are taken from the nursery, is no reason why they should be planted in this condition. Cut them back about one-third of their length and cut sharp all bruised ends of the thicker roots.

Because most shrubbery is green, even in its flowering season, it is safe to use it in any green leaved variety against most any home. Remember that nature disposes of her flowers against trees and shrubs as a background. You seldom find them growing in beds alone.

Flowers planted in beds, displayed in curious shaped utensils, pots, urns and pans, scattered about a yard, are unnatural. They are harsh and correspond to museum specimens. Flowers can best be planted as borders to shrubbery.

Don't forget that your back yard offers as many possibilities in home gardening as your front yard.

Arrange your planting plan to "plant out" objectionable things. Garages, telephone poles, alleys, out houses and other things can be made less offensive and many times "planted out" altogether through careful planning.

Fruit and vegetable gardens are not only productive, but can be made ornamental. Arranging them in an orderly way and surrounding them with a good looking border produces a highly ornamental appearance.

Remember, the success of home gardening does not

rest entirely with your plan. Your plants, flowers, trees, and shrubs need constant care and attention. Your soil must be well nourished and adapted to the gardening plan you adopt.

Be sure about your top soil. Perhaps your building site has a top soil of rich loam—just the kind of soil for proper planting. If so, you are fortunate. See to it that during the excavations for your house this top soil is saved and placed in a pile by itself. Don't permit workmen to mix it with sand and gravel. This mistake is frequently made and home builders wonder why their trees and shrubs don't grow and flower.

It's important to have a good deep top soil. You must provide it if you hope for satisfactory lawn and home gardening results. If the natural soil on your ground is of poor quality, excavate the planting areas about 20 inches deep and fill them with good soil. If you want a good lawn and the natural soil is not of good quality, at least 6 inches deep, cover your lawn with a good top soil before seeding.

Buy your gardening materials and supplies from reputable nursery men. Quantities of gardening stuff are sold that will not grow and mature. Buy only what you know to be hardy in your own locality.

The four things to bear in mind in planting shrubs are not to crowd the roots into bunches. Let them spread naturally. Plant them as deep as they grew in the nursery. Pack the earth firmly around the roots and use plenty of water.

CHAPTER XIX.

THE UPKEEP OF THE HOME AND A FEW FIRST-AID HINTS

THE home is completed; you are living in it; everything is fine. Let us keep it that way. Don't let it deteriorate in any way. Keep it in first-class condition. And when anything does go wrong—and that is likely to happen on occasion, for the home is an assembly of many intricate things—attend to it immediately, for that is the cheapest and best plan in the long run.

The main item of upkeep about the home is paint. If the home is of frame, it must be painted every two or three years to prevent serious deterioration. This applies more particularly to clapboard siding. It requires no expert to tell when the siding needs paint. Powdered appearance of the paint, cracked surfaces, marked discloration and other equally positive signs mean a painting job.

It is optional with the home owner whether it is to be a home-made job or not. If the home owner is handy and if all parts can be readily reached with a

ladder, there is no reason why he should not do the work himself. If, on the other hand, the walls are high and there are places which can only be reached with a scaffold, then by all means turn it over to the local painter whose bid is the most favorable. Use good paint and good workmanship. Perhaps one coat of paint may do, if the surface is still in fair condition; but as a general rule two coats are necessary for a first-class job. Sometimes the paint wears unevenly on the four sides of the house, due to sun and wind exposure. In such instances one coat may be used on the less exposed sides, and two coats on the exposed.

The trim—window frames, porch pillars, door frames and so on—should also be painted. Even the masonry house has a certain amount of wood trim which should be painted at regular intervals.

The chapter dealing with paints and painting covers all the average home owner need know regarding the essentials of the phase of upkeep. Paint manufacturers supply excellent literature which will give specific details on particular painting jobs, and full use should be made of such service.

WITH HAMMER AND NAILS

The handy home owner should have a kit of tools if he wishes to save money. The apartment house dweller seldom has more than a screw-driver and a tack hammer in his kit of tools, but then these tools are ample for all his requirements. The janitor is at his beck and call for any major repairs; and then, too, it is not his house, so what matters it when something does go to rack and ruin!

The home owner should have a man-sized hammer, a hatchet, a set of various sized screw drivers, at least one wood saw and preferable two—a cross cut and a

rip saw, one or more chisels, a try-square, a plane, a hand drill, a pair of pliers, a monkey wrench, and a vise. Other tools may be added to this collection, but the tools enumerated are of basic importance.

Most important of all, there should always be on hand an assortment of nails. Nails are constantly being used about the home. There should also be an assortment of screws, and even bolts and nuts. It likewise pays to keep odd pieces of lumber which have been salvaged during the building of the home or from packing boxes or other sources. These odd pieces of lumber come in handy for little odds and ends about the house, and in the hands of the really handy man they may even be converted into a sand box for the children, a swing, a garden bench, a dog kennel and whatnot.

There are plenty of odd jobs about the house if the home owner wishes to keep his home keyed up to the highest efficiency. And nothing is more conducive to good work than a set of good tools, kept where they can be readily found in the best of condition for instant use. Most of the simple upkeep jobs may be done by the handy man, such as hanging screen doors, nailing up weather strip, putting up storm windows and storm doors, and so on. The carpenter, who is an expensive gentlemen to call upon, should be summoned only as a last resort, when something of major importance has to be done.

WHEN THE PLUMBING GIVES TROUBLE

The plumbing of the home functions day after day and week after week, year in and year out, with only an occasional failure. And then it is generally a simple matter that may be attended to by the average handy man.

The most common plumbing trouble is the leaking

faucet. The water continues to drip after the faucet has been tightly closed. This means that the little fiber-washer which shuts off the flow of water, is badly worn so that it no longer seats properly to make a perfect seal. The procedure is simple enough. Shut off the water supply of the house at the point where the water supply enters the house, or if preferred, at a point near the faucet if there happens to be a shut-off so located. With the water supply shut off, unscrew the hexagonal top of the faucet with a wrench. The fiber washer is then brought to view. It is removed and a new one of the same size is put in its place. If a larger washer must be used, it can be trimmed down to fit. The faucet is re-assembled and the faucet is ready to perform when the water is turned on.

If the faucet leaks through the top, this indicates the need for packing about the stem. Shut off the water supply, take apart the faucet, and wrap heavy waxed string about the stem. Wrap plenty of string—as much as can be accommodated in the faucet when it is re-assembled. Put the faucet together and the waxed string packing will be found to stop the leak.

Another plumbing trouble is the failure of a fixture to drain properly. This indicates a clogged up soil pipe. Perhaps the clogging is due to some solid object, but as likely as not it is nothing more serious than chilled grease. Try boiling hot water, which will soon dissolve the grease if that is the cause of the trouble. Also try lye, which cuts the grease most effectively. It is well to keep a can of lye or special drain-pipe cleansing preparation on hand at all times, using it occasionally in the kitchen sink even when everything is functioning to perfection. If hot water and lye do not remedy the trouble, then it is a mechanical job. Using a stiff wire or special drain-pipe brush, clean out the drain pipe as far as possible. Remove the plug from the trap beneath the fixture and see whether the

trouble is not due to some accumulation in the trap, which can be readily cleaned out. If the trouble is beyond the trap, then it becomes a more serious matter. It is generally time to call the plumber, who has a powerful force pump to remedy such a situation. Sometimes, when solid objects become jammed in waste pipes, it is necessary to remove part of the plumbing to arrive at the trouble. That is why the drain pipes should be equipped with so-called "clean outs" at strategic points.

WHEN TO BE AN ELECTRICIAN—AND WHEN NOT

The electrical system of the home occasionally goes off, causing great consternation. In such instances the fault is with something or someone in the household, either someone has done something with the electric current which should not have been done or some of the equipment or wiring is defective, hence the shutting off of the current. Thus if the Thomas Edison Westinghouse Junior of the house has inserted a screw driver in a socket to see whether he can melt it or produce fireworks, he is rewarded with very little results, because a little piece of lead wire known as a fuse, usually located in the basement, melts and breaks the electric current supply, saving said Junior from serious injury. All kinds of foolishness which might result in harm are offset by the fuses. Only too often the household looks upon the fuses as a nuisance, when, as a matter of fact, they are guardians in the true sense of the word.

Defective electrical equipment will cause the fuses to "blow." If the electric iron cord is badly frayed as the consequence of constant wear, and the wires come in contact with each other, the fuses will "blow." Defective lamp wiring will also cause a fuse to "blow."

So the first step when the fuses have blown out and

the house is in darkness or at least without electric current, is to ascertain the cause of the blow out. Remember, the fuses are distinctly marked for a certain current capacity, say 6 amperes, 10 amperes, 15 amperes or 25 amperes. If they have blown out, it means that more current than their stated capacity passed through them momentarily. Therefore, if more current is drawn than the fuse rating, the current is bound to be shut off. Occasionally, too much current may be drawn from a single circuit. Thus in a household there may be connected an electric heater, drawing six amperes, and an electric toaster, drawing the same amount, on one circuit fused for ten amperes. Of course, the fuses must "blow" under such circumstances.

Always determine what has been done to make the fuses blow out. If the fuses blew out following the attachment of a certain bit of electrical equipment, disconnect said equipment. Now, then, go to the fuse box, generally located in the basement. Look at the fuses, which generally have little transparent windows which show the fuse link plainly. If the fuses are blown out, the connecting link will not show. Replace the blown out fuses with fuses of the same rating, and the current should be restored to the house. If it is not, then the trouble is beyond the house wiring and probably in the service box, in which event the electric light company must be summoned. It means that the house wiring fuses did not blow soon enough to prevent the service fuses from blowing out, as well.

Meanwhile, do not connect the defective device in the electric circuit until it has been examined and the trouble rectified.

Keep a supply of spare fuses on hand at all times, of the same rating as the fuses originally installed by the electrician. Do not use fuses of higher rating, for while it is true that they will not blow out as readily,

they may cause the destruction of faulty electrical apparatus with disastrous results, as well as cause fires through defective wiring.

The average handy man should be capable of doing the simplest kind of electrical repairs. The electric iron needs repairing from time to time. This job is nothing more serious than the burning out or breaking of the wire connections in the connector, due to the great heat generated by the iron. Unscrew the block, undo the wire connections, cut both wires to an even length, skin the insulation, reconnect to the metal clips, and reassemble the plug. It goes without saying that this and other kinds of electric wiring should be done with the device disconnected from the electric supply.

Extension lamps may be readily wired. All that is required is that the two wires being kept separated one from the other, and firmly gripped under their respective binding screws, when connected with the socket or the plug. Unless the handy man has seen someone else connect sockets and plugs, he had best leave this work alone.

When it comes to the permanent wiring of the home, we are invading the legitimate field of the electrician. Do not fool with the permanent wiring. Call the electrician. And don't jeopardize your fire insurance protection.

Most emphatically, at this time the author wishes to discourage the would-be electrician of the home who installs all manner of extraneous electric wiring, such as closet lights, bed lights, cellar lights, remote switches and so on, wired with parallel lamp cord or twisted lamp cord held on the ceiling or wall with staples or tacks and connected with some socket or outlet receptacle of the real wiring system of the house. Such extraneous wiring is highly dangerous. More fires start from this source than from any other. Furthermore, the fire insurance policy does not cover fire risks from

such wiring, which is against the rules of the fire underwriters and is a positive menace. If there is need for the added convenience of such wiring, by all means spend the necessary money and have a real electrician put in approved wiring to cover these needs.

Bell wiring is simple enough and involves no danger of any kind, inasmuch as no great current is used. The handy man may install the bell wiring with little trouble, running a pair of wires from the push button to the bell but inserting in one of the wires one to three cells of dry battery. If preferred, he may install what is known as a bell-ringing transformer, which is simply a small transformer operating on the alternating current supply used for lighting. Such a transformer draws very little current and operates the bell in an unfailing, constant manner, doing away with batteries.

CARING FOR THE HEATING PLANT

Once in a while the heating plant requires something in the way of repair or adjustment, aside from the task of firing it during the cold months of the year. The main job here is to clean out the heating plant at least once a year, at the beginning of the cold season. All furnaces and boilers are provided with a "clean-out" door through which the inside heating surfaces may be reached for the purpose of removing ash dust and soot. The accumulation of ash dust and soot serves to insulate the heating surfaces, thus reducing materially the heating efficiency of the heating plant. Hence the importance of cleaning out the heating plant at least once a year, generally at the beginning of the cold season.

The draft pipe should also be cleaned out, for it becomes clogged with an accumulation of soot and ashes which reduces its diameter and therefore the

draft. The pipe can be taken down in sections and brushed out clean.

The chimney also requires a seasonal cleaning to remove soot and ash deposits. The usual way of cleaning the chimney is to dangle a brick on the end of a long string down into the chimney, and let the brick hit the sides of the chimney, thus shaking off the deposit. A more effective way of doing this job is to get a small spruce, pine or cedar tree which will fit the chimney flue rather tightly. Two ropes are attached to the tree, one passing up to the top of the chimney, and the other passing down to the bottom. Then, with one man at the top and another at the bottom, the tree is pulled up and down, shaking loose the soot and ash deposit which falls down below where it can be removed. The tree may have to be reversed each time, so as not to break off all the branches if it fits rather tightly.

As for the mechanism of the heating plant, especially the more complicated hot-water, steam and vapor systems, the reader is referred to the manufacturer of the particular plant he is using. Manufacturers issue complete and comprehensive directions on the operation and care of their heating plants. Such directions are often in the form of instruction cards, which are tacked up near the heating plant so as always to be available for instant reference.

STORM DOORS AND STORM WINDOWS

Whether a home is exposed to the cold north winds or not, it pays to install storm windows and storm doors. The purpose of these windows and doors is to form a dead air space between the inside atmosphere of the home and the outside atmosphere, and while these extras are rather expensive, they will be found to pay for themselves many times over in the course of years.

It is not an uncommon experience to have these storm windows and doors save 20 per cent in the coal consumption, aside from eliminating troublesome and uncomfortable drafts which give rise to colds and other ailments.

Weather strip should be freely used about the house. Even with the best carpentry work there are usually slight cracks about doors and door frames and between windows and window frames, through which air pours in under the driving influence of wind. Weather strip can be obtained in various styles and materials, and it usually pays to use the metal weather strip in preference to the wood weather strip, because of the better wearing properties of the former. Weather strip should be nailed up close to windows and doors so as to mask the tiny cracks through which air gets into the house.

Felt in strip form is also handy for making the house air tight. Strips of this material can be placed around doors, in window frames, and packed in troublesome cracks. Oakum—hairy-like material—is also employed for plugging up cracks, especially in hollow-tile construction where the mason has not been careful to fill in about the window frames or where the window and door frames have shrunk somewhat so as to leave gaps between wood and masonry. In the case of masonry houses the window and door frames should be examined occasionally to make certain that such shrinkage of wood as may take place does not cause wide gaps which are left unfilled. Plug up such gaps, using mortar or cement if possible, or at least oakum or strip felt; otherwise, the house will be “leaky” so far as air is concerned, and will prove very expensive in fuel consumption. Not only in the matter of air or drafts, but also as regards driving rain, is there cause for much concern when there are bad cracks and gaps in the house walls.

WHEN THE ROOF LEAKS

The roof, no matter how good and how well laid, may possibly spring a leak. This is quite understandable when we remember that the usual shingle roof is made up of a great many separate pieces which are overlapped so as to form a single covering. These overlapping pieces introduce a very great number of joints which may possibly become defective at times. A slight roof leak, therefore, is not a serious matter and may be readily attended to.

There are certain roofing compounds on the market which serve to stop leaks. These compounds are of a tar-like composition, quite plastic and sticky. They may be applied with a heavy brush, if a large surface is to be treated, or with a painter's scrapper or putty knife if one or a few definite cracks are to be plugged up. This material may be applied from the attic side of the roof, if necessary, although the best job is done when the material is applied on top of the roof. In case of wood roofs, additional shingles can be inserted if necessary to cover up a bad spot. Heavy mastic compound can be applied to fill small cracks. A piece of tin or other material can be used to cover a small hole, and then painted over with the roofing compound. Composition shingles can be repaired in about the same manner.

Gutters and leaders can be repaired by the average handy man. If the gutters become clogged up and the water backs up, pouring over the roof instead of going down the leaders, it indicates that leaves have plugged up the entrance to the leader pipe. A few minutes' search and a little cleaning will rectify the trouble. Leader pipe can be readily replaced, since one section is wedged into the next section, unless a neat, soldered job is required.

HOUSEHOLD USES FOR CEMENT AND CONCRETE

It will be found convenient to keep a small quantity of Portland cement for household repairs. This may be preserved indefinitely in a moisture-proof container, such as a covered tin can or glass jar.

Defects in the concrete and masonry of a house arise from careless construction, settling, and other causes and are not uncommonly sources of more or less serious trouble. One of the most common cases of this sort is a leaky basement due to cracks in the floor or imperfect joints in the walls. Small leaks of this sort can usually be repaired by the use of cement alone or, preferably, by the use of cement mixed with 1 to 2 parts of sand. For example, suppose that a narrow crack has developed in a concrete basement floor which lets in a considerable amount of water. To repair the defect, chip away the concrete on both sides of the crack to a width of $\frac{3}{8}$ or $\frac{1}{2}$ inch and to a depth of $\frac{1}{2}$ inch or more and clean away carefully all the loose material. Then thoroughly saturate with water the concrete along the crack, allowing it to absorb as much water as it will. Next make a thin cream or "grout" of cement and water, and with a small stiff brush apply it freely to the sides of the channel which has been chiseled out. Finally, mix a sufficient quantity of 1 : 2 mortar, using only as much clean water as will allow it to be handled readily with a trowel, and fill the channel with it as completely as possible. After the mortar has set, and especially if the air in the basement is fairly dry, the floor in the vicinity of the cracks should preferably be kept wet for a few days by covering with wet sand, burlap, or by frequent sprinkling, to insure proper hardening and a good bond between the fresh mortar and the old. Repairs of joints in brick, tile, stone, and concrete-block walls can be made in a similar manner. Here the old mortar should be raked out of defective

spots and the process of wetting, grouting, and filling followed as outlined above. Serious leakage in basements is rather difficult for the householder to overcome by his own unaided efforts and usually requires the installation of proper drainage with a considerable amount of repair work or even reconstruction. In most cases, however, good cement mortar or concrete is the material that must be depended upon to effect the repairs.

A similar mixture may be used for plastering a brick wall, adding, however, hydrated lime (about 10 per cent by weight of the cement) in order to make it more plastic. One of the most essential features is to have the wall thoroughly clean and saturated with water before applying the cement mixture. Two or more thin coats troweled hard are better than one thick coat. This mixture is nearly impermeable to water;

hence, nothing is gained by using the so-called "water-proofing" compounds, most of which are worthless.

Rats, mice, and other vermin usually obtain access to houses from the basement through openings into partitions or walls at the first-floor level or else through holes cut for pipes, electric conduits, etc. The fundamental remedy for this type of annoyance is to have the upper part of the house absolutely sealed off from the basement except at the closed door at the head



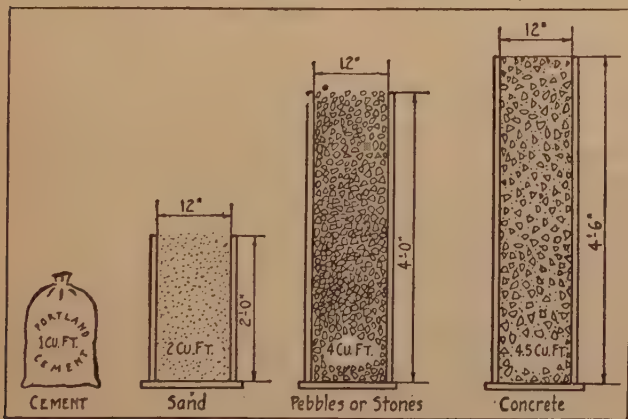
Simple equipment for concrete work about the home.—(Courtesy Portland Cement Association)

of the basement stairs. The methods of closing all other openings between basement and first-floor level depend upon the type of house, but the householder may bear in mind that cement mortar is absolutely rat and vermin proof and can always be used to seal openings in masonry and concrete. In certain cases large openings between floor joists or studs can be most effectively closed by the use of expanded metal lath or stout wire netting of $\frac{3}{8}$ to $\frac{1}{2}$ inch mesh and cement mortar. Small openings in woodwork, such as knot holes and large cracks, can also be sealed with mortar, but because the latter is brittle and does not bond well to wood some means must usually be provided to hold it permanently in place. A simple means of doing this, which will answer in most cases, is to drive brads or nails into the wood in such manner that they will be covered by the mortar and support it firmly when set.

Cement is adapted to other repairs about the house, but space is lacking for more than a few general suggestions. It has been used successfully in the sealing of cracks in laundry tubs, furnace casings, and fireplaces; holes where water and gas pipes enter the basement and joints and breaks in drain pipes and vents; in connecting smoke pipes to chimneys; in repairing breaks and cracks in concrete walks and steps; and in patching stucco. In relation to the last three items it is to be borne in mind that cracks occurring in any type of cement-finishing work are generally an eyesore rather than a serious injury which interferes with the purpose they serve, and that any attempt to repair them should not be made unless an improvement in appearance is assured beforehand. The patching of exposed cement work in such a manner that the patch does not show disagreeably is, unfortunately, difficult of accomplishment. The finishing which cement works takes on through weathering is hard, if at all possible, to match.

HOME-MADE CONSTRUCTION WITH CONCRETE

Especially to the farmers and home owners who live outside the crowded districts of large cities, and who by reason of circumstances or natural inclination are interested in improving their property by the work of



The ingredients of concrete. Note that a cubic foot of cement, two cubic feet of sand, and 4 cubic feet of stones, go to make $4\frac{1}{2}$ cubic feet of concrete, which will make a concrete wall 12 inches thick and $4\frac{1}{2}$ feet high.—(Courtesy Portland Cement Association)

their own hands, Portland cement offers many possibilities. Anyone possessing a little mechanical ability and a few tools can, with the aid of Portland cement, build a great variety of household accessories ranging in size from match holders and ash receivers to water tanks and coal bins; on a somewhat larger scale one can put in many permanent improvements, among which may be mentioned walks, floors, steps, driveways, fence posts, benches, watering and feeding troughs, retaining walls, foundations for out buildings, refuse

burners, hotbeds, cold frames, culverts, cisterns, tanks, swimming pools, and silos.

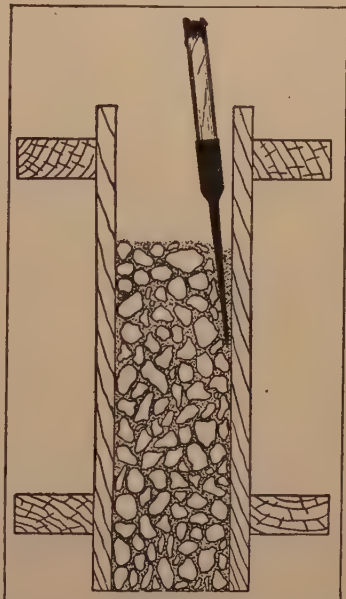
The proportions of cement, sand, and gravel to be used in mixing concrete should be varied according to requirements, but for home use on a small scale good results will be obtained by using 1 part by volume of cement, 2 parts of sand, and 4 parts of gravel or broken stone. In estimating the quantities required for any particular job it is first necessary to determine how many cubic feet or yards will be occupied by the finished concrete. Suppose, for example, a cement walk is to be built 40 feet long, 2 feet wide, and 4 inches thick, of 1 : 2 : 4 concrete. The walk will contain 40 by 2 by $\frac{1}{3}$ cubic feet, approximately 27 cubic feet, or 1 cubic yard. Now, it is obvious that if 4 cubic feet of cement, 8 cubic feet of sand, and 16 cubic feet of gravel are ordered for the job the amount of mixed concrete will fall short of what is required, for the cement and sand together will largely go into the spaces between the pieces of gravel, and the volume of the mixed concrete will be somewhat greater, but not much greater, than the volume of the gravel alone. Hence, a general rule to be followed on small jobs is to order a volume of gravel or broken stone equivalent to the volume of the finished concrete, one-half as much sand, and one-quarter as much cement; that is, when the above proportions are to be used. For mixtures richer than 1 : 2 : 4 generally a lesser volume of materials will be required, the exact volume of concrete to be obtained varying with different materials.

The detailed construction of many of these improvements can not be given here, but certain general information on the use of cement and concrete materials and a few specific directions for typical examples of concrete work about the home will be presented in such manner as to indicate the method of dealing with any particular problem.

CONCRETE MATERIALS AND TOOLS REQUIRED

The materials required for concrete work are cement, sand, and gravel or broken stone. Cement is sold by the sack containing 94 pounds net or approximately 1 cubic foot. The price varies considerably in different localities, but in small lots can usually be obtained from 50 to 75 cents per sack. Sand and gravel or broken stone are usually sold by the cubic yard (27 cubic feet) or by the ton, the price depending largely on the source of supply and the distance the material has to be hauled, the price ranging between \$0.50 and \$2 per cubic yard.

The tools required for mixing and placing concrete by hand are a mixing board of 8 to 10 feet square, preferably of tongued-and-grooved dressed lumber. This is large enough for two men to mix at one time $\frac{1}{4}$ to $\frac{1}{3}$ of a cubic yard of concrete. For small "one-man" jobs a mixing box 2 to 3 feet wide and 4 to 6 feet long with sides 6 to 8 inches high will be found convenient. If the ends of the box are sloped inward at the bottom



Spading concrete next to form faces causes the concrete to settle to its utmost density. Spader is made of wood.—(Courtesy Portland Cement Association)

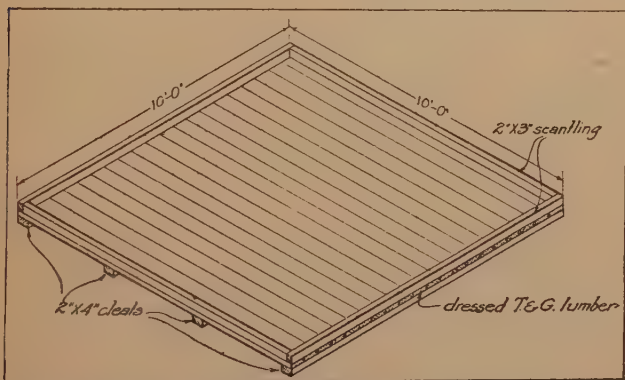
and a single piece of sheet iron just the inside width of the box is laid along the bottom and carried up over the ends, the labor of mixing will be considerably reduced. The other tools required are usually included in the average household kit, viz, a shovel, a rake or hoe, a spade, a wheelbarrow, and three or four water buckets. If the job is large enough to require two or more men on the mixing platform, a shovel for each man will be necessary, or one man may use a rake while the others shovel. If the job is a small one, the hoe and mixing box can be used to better advantage. After mixing the concrete it can be handled either in buckets or wheelbarrows, and the spade is to be used in working the concrete into place in the forms. If for any reason a comparatively dry mixture is to be used, a tamper will be found useful. This can be purchased or easily made from a short piece of timber 4 to 6 inches square provided with a suitable handle.

FORMS FOR CONCRETE

As concrete is a semiplastic material to be cast in some definite shape or form, molds of some sort are always required to hold it in place until it has hardened sufficiently to support itself and any additional load to which it may be subjected. In most cases the molds are made of lumber and are commonly known as "forms." Good forms are essential for good concrete work, and they add considerably to the total cost of concrete construction. In general, the greater the height of the structure the greater the proportionate cost of form work, for concrete is nearly two and one-half times as heavy as water, and the forms must be sufficiently well braced to withstand the pressure of the freshly mixed material.

The quality of the form work for any particular purpose depends largely on the character of the finished

concrete surface desired. If the finished surface is to be smooth and free from pits and pockets, the forms must be of dressed lumber and mortar-tight, in fact, as nearly water-tight as possible. For example, in casting a bench or table the results will be much more pleasing if the exposed sides and corners are run smooth and true in the forms than if the finished work requires "pointing" or retouching to any considerable extent. In such work the forms must be very carefully built



Simple mixing platform of this size will mix enough concrete for a good-sized job about the home, and requires the services of two or more men.—(Courtesy Bureau of Standards)

and securely braced and the concrete thoroughly worked into place, for the finished job will reflect every imperfection in the forms, even to the knots and grain of the wood. In fact, the results to be obtained in concrete ornamental work of any kind depend almost entirely upon the quality of the forms, and in many cases it is desirable to use sheet metal where a very even surface is required. Either wood or metal forms must be well oiled with mineral oil (kerosene is good) before the concrete is "poured," not only to enable the

forms to be taken down easily but in the case of wood to prevent absorption of water from the face of the concrete, which otherwise is likely to result in a weak or dusty surface.

For other than ornamental work such painstaking care is not required in the construction of forms. For walks and roadways, foundation walls, and miscellaneous construction work about the home or farm forms of rough lumber will generally meet the requirements, provided always they be properly braced.

METHODS OF PROPORTIONING, MIXING, AND PLACING

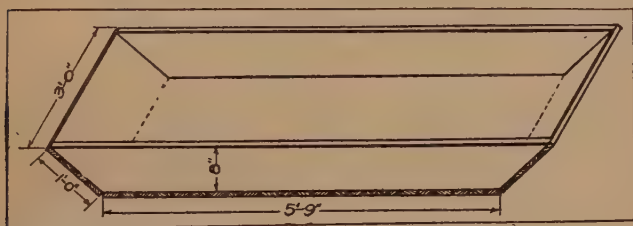
The measuring and proportioning of concrete materials for small jobs can most readily be done by means of water buckets, the 16-quart size in particular being recommended because it holds approximately $\frac{1}{2}$ cubic foot. If these can not readily be obtained, bottomless boxes holding 1 cubic foot or more can be easily made for measuring the dry materials.

If enough concrete is to be mixed to require the use of a mixing platform, the following method of procedure is recommended: if 1 : 2 : 4 concrete is to be made, measure out 8 buckets of stone and spread it on one side of the platform to a depth of 3 or 4 inches; measure out 4 buckets of sand and spread it on top of the stone. Next measure out and spread over the sand 2 buckets of cement, taken as compacted in the bag. The stone, sand, and cement are then to be mixed dry by shoveling into a pile on the other side of the board, not by dumping the shovelfuls in a mass in one place but by shaking off and distributing the shovelfuls so that the materials will mix as they fall. A second mixing should then be given in the same manner by shoveling the pile back to its original position and spreading out as before. Now wet the mass down, using a bucket or hose, being careful not to use too

much water. The whole is now to be shoveled back and forth until the stones are well coated with the sand and cement mixture, and enough water is added to enable the concrete to be rammed or spaded into place. The mixing of the stones and mortar is greatly facilitated if one man uses a rake and adds the water as required while the others shovel.

For a smaller quantity of concrete the mixing box may be used. The sand and cement are first mixed dry with a hoe, and the water may then be added and mixed to a mortar. The gravel or broken stone is then worked into the mortar with a final hoeing.

When the mixing has been completed, the concrete is shoveled into buckets or wheelbarrows and dumped into



Mixing box or trough, for mixing small quantities of concrete for repair jobs and small construction about the home.—
(Courtesy Bureau of Standards)

place. The quality of the concrete is greatly improved if during the placing of the mixture it is worked and spaded so that all corners of the forms are well filled and most of the air pockets and voids are eliminated. The mixture should be mushy but not watery. Spading the concrete against the forms brings a layer of smooth mortar to the outside surface, and if the mixture does not seep out at holes or cracks in the forms the resulting surface will be uniform in appearance and show neither sand nor stone. Lightly tapping the outside of

the form after the mixture is placed will also assist in obtaining a good surface.

WATERPROOFING AND SURFACE TREATMENT

The home owner will not be especially interested in the question of waterproofing cement mortar and concrete unless he has a leaky basement, inferior stucco on the walls of his house, or is planning to build concrete water tanks for some purpose. In the case first cited he may be assured that if the cement work were properly done in the first place he would not be having trouble and that it will require only good cement mortar and concrete to make the basement tight. The repair of stucco is a more serious matter and cannot be dealt with here for lack of space. Water tanks may be made absolutely water-tight by the use of 1 : 2 : 4 concrete alone without any waterproofing treatment, provided the material is properly mixed and placed in one continuous operation, the concrete being well spaded against the surface of the forms.

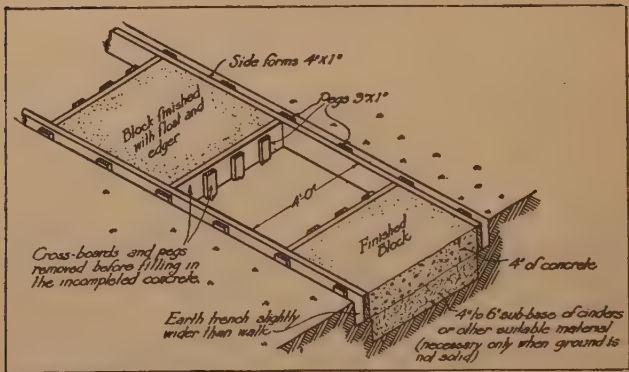
The finishing of large concrete surfaces, such as walks and floors, in a manner to produce satisfactory results is the only difficult part of concrete work for the amateur, yet with a little care and practice he can meet all his back-yard requirements and feel assured that his work will give just as good service as that of the expert who put in the ornamental approach to his front door. The methods to be followed can be most conveniently outlined in the examples of concrete construction hereafter described.

Cement walks and floors not infrequently give trouble from "dusting" and wearing away of the surface to a rough gritty condition. This is usually the result of bringing too much fine cement to the surface in troweling or of allowing the freshly finished surface to dry out too rapidly. This condition, though entirely

a fault of construction and not of material, is, nevertheless, a serious defect. Aside from the use of commercial floor hardeners, there are two methods of remedying the dusting of concrete floors, both of which are inexpensive and probably as effective as the majority of compounds to be obtained in the market.

The first of these is the application of a water-glass solution (purchased in concentrated form and diluted with 4 to 6 parts of water) in the following manner: First wash the floor thoroughly, removing all dirt and loose particles with broom or scrub brush, and allow it to dry. Then apply the water-glass solution with a brush (a whitewash brush with a long handle is most convenient). This solution will penetrate into the concrete and will soon dry. A day or two later again wash off the floor, using a mop and clean water, and after it has dried again apply the water-glass solution. This treatment is to be repeated until the water-glass solution is not absorbed by the concrete, after which a final washing completes the process. Two or three applications are usually sufficient unless the concrete is very porous. In this case the solution may be made up with less water, say 3 to 4 parts.

The second method is to paint the floor with boiled linseed oil, applying coats on successive days until the oil is no longer absorbed. The oil should be thoroughly brushed into the surface. This treatment fills the pores with a hard elastic gum and appears to be even more effective than the water-glass treatment. On the other hand, it is somewhat more expensive and gives a darker finish than the latter. The use of an oil paint on concrete floors is not generally to be recommended. Most paints will scale or peel from such floors in places, and no subsequent treatment will ever be entirely satisfactory. Some paint manufacturers put up a special hard paint intended for surfacing concrete floors, which gives an attractive as well as durable finish.



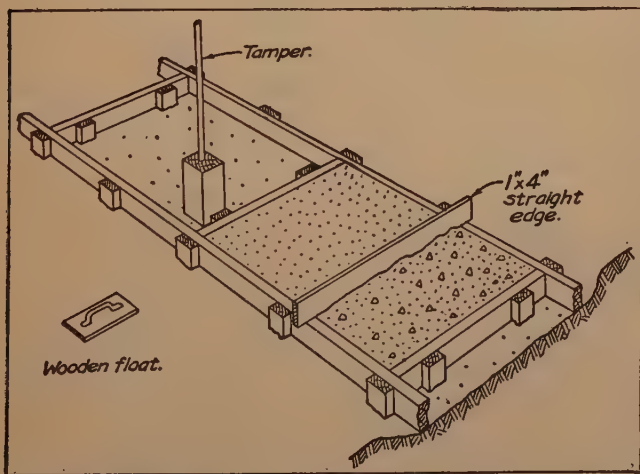
Details of laying a concrete walk, showing the cinder sub-base, side forms, cross-boards, pegs, and alternate blocks cast at one time.—(Courtesy Bureau of Standards)

LAYING A CONCRETE WALK

The very great majority of troubles with concrete walks and pavements arises from poorly prepared foundations or sub-bases, and if the home owner will give proper attention to this point he can build a better walk than he can usually buy from a contractor. If the walk is to be laid on fairly level, solid ground, no considerable preparation of the sub-base is necessary. In this case dig a shallow trench, the bottom of which is 4 inches below the surface of and a few inches wider than the finished walk. The side forms are to be constructed of 4-inch boards held in place by pegs on the outside and by 4-inch cross boards on the inside, which mark out the squares or blocks. The tops of all these form boards should be accurately lined to the finished surface and must be held with pegs in such manner that they will not move while the concrete is being placed and finished.

After the forms are in place see that all loose dirt is

removed and the sub-base well tamped, wetting it if necessary, to secure a solid bottom. The concrete may then be placed in the following manner: First saturate the sub-base with water, then make a moderately dry mix of 1 : 2 : 4 or 1 : 2½ : 5 concrete, and begin to fill alternate sections or squares of the walk. The concrete should be thoroughly tamped in place and should be mixed fairly dry; that is, not quite wet enough to "quake" under the tamper. Continue this process with as many sections only as can be completely finished before the work is interrupted. The top layer of each section, to a depth of 1½ inches, should be filled with a somewhat wetter mix which will require only moderate tamping to bring the mortar to the surface. As the sections are filled go over them with a straightedge resting on the front and back edges, striking off the



How the cinder sub-base is tamped down solid and how a straight-edge is used for getting a level surface.--(Courtesy Portland Cement Association)

excess concrete with a backward and forward movement. Two or three times over will leave the top flat except for marks of the straightedge. From the standpoint of service, however, a better surface can be obtained by using a wooden float in finishing instead of a trowel. In this manner an even and more or less sandy surface is produced, which not only tends to hide slight defects of finish but affords a better grip to the shoe.

Unless one is experienced in cement finishing it is better not to attempt any unnecessary decorative work, such as marking the surface into small squares or other patterns, constructing curbs, etc. The only finishing tool required, aside from float and trowel, is an "edger," with which to round slightly the edges of the finished blocks. This is done immediately after the troweling or floating has been completed and eliminates the sharp and slightly ragged edges which would otherwise remain and be unsightly after the forms are removed.

Up to this point alternate squares of the walk are completed, and it is desirable, but not necessary, that they harden for several days before the remainder of the walk is constructed. The cross forms should be taken down as soon as the concrete already placed is fairly hard, and the remaining squares are to be filled in between the completed blocks. The advantage in waiting a few days is that the blocks first laid are less liable to be injured by the subsequent work, but with care the walk can be finished in two or three days. The same method is to be followed as before, except that in finishing at the joints between blocks a little more care is required in running the edger and in cleaning off any fresh mortar from the blocks first laid.

It is important that the newly laid walk be kept from drying out for several days, in order that the concrete may harden properly and develop a good wear-

ing surface. The most efficient method of doing this is to cover the walk the day after it is laid with 3 or 4 inches of earth and wet it down thoroughly twice a day for a week. After this the earth may be removed, and the walk cleaned thoroughly, thus completing the job in a satisfactory manner.

The object in laying a walk in the manner described in the preceding paragraphs is partly to make it an easier task for the amateur, who can handle the separate sections with greater certainty than a long unbroken stretch of walk, but mainly to insure that the walk is laid in separate units, which in case of uneven settlement or upheaval by frost are much less likely to crack than long sections. There will, of course, be considerable bond between the adjacent blocks, but since the weak places are at the joints, cracks will be more likely to occur there than elsewhere. If they do occur there they will neither injure the appearance nor the serviceability of the walk.

When a walk is to be laid on filled or soft ground, special attention must be given to the foundation. Unless urgently needed, a concrete walk should not be built on filled ground until the latter has settled for several months or longer, and even then the foundation must be well prepared to insure a satisfactory walk. Preferably, the walk should be made thicker or reinforced as an added precaution. In most cases the following procedure will give good results. Excavate to a depth of 6 inches below the grade of the walk and place the side forms with small stakes on the outside, driven down about 18 inches below grade, spaced not over 2 feet apart. The side forms may be held in place by nailing them lightly from the inside to each stake. Inside the forms excavate about 4 inches more, so that a trench 10 inches deep is formed. Tamp the earth in the bottom solidly and fill in with well-rammed broken stone, brickbats, broken concrete, hard cinders (not

fine ashes), or whatever material of this type is available to a depth of about 6 inches. Cross forms of 4-inch boards may now be placed and the laying of the walk carried out as previously described. In spite of these precautions, if the walk is laid near the edge of filled ground, it is liable in time to settle or move sideways in the direction of the slope of the ground. This movement can generally be prevented if additional fill is put in outside the walk so that the edge of the fill, to which the "slumping" is mainly confined, is 2 or 3 feet away. Many examples of this fault are seen in newly developed residential sections, where hastily laid concrete walks could be saved from early destruction at little extra expense in the manner suggested.

CHAPTER XX.

TABLES AND CONDENSED FACTS

IN the accompanying pages the author has endeavored to present miscellaneous tables and condensed facts that are of lasting value to the average home owner. Material of this kind may be supplemented by obtaining the excellent literature of building material companies and associations. Thus for additional material on concrete and its uses, the reader should secure the valuable literature of the Portland Cement Association and the various individual cement companies. Additional material on lumber and its uses may be obtained from the National Lumber Association and the various individual lumber companies. Additional material on paints and painting may be obtained from the paint manufacturers, brick information from the brick associations, and so on. By all means supplement this work with the literature now available for the mere asking.

The reader is especially recommended to the Bureau of Standards of Washington, D. C. This wonderful organization has done a vast amount of research work and experimentation of real benefit to home builders and home owners. Such publications as Circular No. 70, "Household Materials"; Circular No. 55, "Measurements for the Household"; Circular No. 75, "Safety for the Household," are available at modest prices from the Superintendent of Documents, Government Printing Office, Washington, D. C.

• • WEIGHTS AND MEASURES

Linear Measure:

12 in. equals 1 foot
 3 ft. equals 1 yard
 5.5 yards equals 1 rod
 40 rods equals 1 furlong
 8 furlongs equals 1 mile

Square Measure:

144 sq. in. equals 1 sq. ft.
 9 sq. ft. equals 1 sq. yd.
 30¼ sq. yds. equals 1 sq. rod
 160 sq. rods equals 1 acre
 640 acres equals 1 sq. mile

Surveyor's Measure:

7.92 inches equals 1 link
 25 links equals 1 rod
 4 rods equals 1 chain
 100 links equals 1 chain
 60 ft. equals 1 chain
 80 chains equals 1 mile

Surveyor's Square Measure:

625 sq. links equals 1 sq. rod
 16 sq. rods equals 1 sq. chain
 10 sq. chains equals 1 acre
 640 acres equals 1 sq. mile
 36 sq. miles equals 1 township

Cubic Measure:

1728 cu. inches equals 1 cu. ft.
 27 cu. ft. equals 1 cu. yd.
 128 cu. feet equals 1 cord
 24¾ cu. feet equals 1 perch

Measure of Angles or Arcs:

60 seconds equals 1 minute
 60 minutes equal 1 degree
 90 deg. equals 1 rt. angle or quadrant
 360 degrees equals 1 circle

Avoirdupois Weight:

437.5 grains equals 1 ounce
 16 ounces equals 1 pound
 100 pounds equals 1 hundred-weight
 20 cwt. or 2,000 lbs. equals 1 ton

Long Ton Table:

16 oz. equals 1 pound
 112 pounds equals 1 hundred-weight
 20 cwt. or 2,240 lbs. equals 1 ton

Troy Weight:

24 grains equals 1 pennyweight
 20 pennyweights equals 1 ounce
 12 ounces equals 1 pound

Dry Measure:

2 pints equals 1 quart
 8 quarts equals 1 Peck
 4 pecks equals 1 bushel

Liquid Measure:

4 gills equals 1 pint
 2 pints equals 1 quart
 4 quarts equals 1 gallon
 31½ gallons equals 1 barrel
 2 barrels equals 1 hogshead

METRIC WEIGHTS AND MEASURES

APPROXIMATE EQUIVALENTS OF THE FRENCH (METRIC) AND ENGLISH MEASURES

1 yard	11/12 meter.
11 meters	12 yards.
To convert meters into yards.....	Add 1/11
1 meter = 1.1 yd.; 3.3 ft.....	3 ft. 3¾ inches (1/512 less).
1 meter, by the Standards Com-	40 inches (1.6 per cent. less).
mission	= 39.38203 inches.
1 meter, by the Act of 1878.....	= 39.37079 inches.
1 foot	3 decimeters (more exactly 3.048).
1 inch	25 millimeters (more exactly 25.4).
1 mile	1.6 or 13/5 kilometers (more ex-
1 kilometer	actly 1.60931).
1 square yard	5/8 of a mile.
1 square meter	6/7 square meter (more exactly
1 square inch	.8361).
	10¾ square feet or 11/5 sq. yds.
	6½ square centimeters (more ex-
	actly 1.60931).

1 square mile (640 acres).....	260 hectares (0.4 per cent. less).
1 acre (4,840 square yards).....	4,000 square meters (1.2 per cent. more).
1 cubic yard	$\frac{3}{4}$ cubic meter (2 per cent. more)
1 cubic meter	$1\frac{1}{3}$ cubic yards ($1\frac{2}{3}$ per cent less).
1 cubic meter	$35\frac{1}{2}$ cubic feet (.05 per cent less).
1 cubic meter of water.....	1 long ton nearly.
1 kilogram	2.2 pounds fully.
1,000 kilograms	1 long ton nearly.
1 metric ton	51 kilograms nearly.
1 long hundredweight.....	$45\frac{1}{2}$ kilograms nearly.
1 United States hundredweight..	

MISCELLANEOUS WEIGHTS

Material	Wgt. in Lbs. per Cu. Ft.	Material	Wgt. in Lbs. per Cu. Ft.
Bbl. Lime	50	Stone Concrete	130 to 150
Bbl. Cement Plaster.....	73	Paving, Asphaltum	100
Box Tin	278	Plaster of Paris.....	140
Box Glass	60	Glass	160
Paving Brick	150	Spruce	25
Common Building Brick.....	120	Hemlock	25
Soft Building Brick.....	100	White Pine	25
Granite	170	Douglas Fir	30
Marble	170	Yellow Pine	40
Limestone	160	White Oak	50
Sandstone	145	Common Brick Work.....	100 to 120
Slag	40	Rubble Masonry	130 to 150
Gravel	120	Ashlar Masonry	140 to 160
Slate	175	Cast Iron	450
Sand, Clay and Earth (dry).....	100	Wrought Iron	480
Sand, Clay and Earth (wet).....	128	Steel	490
Mortar	100	Portland Cement	90

HANDY FACTS ABOUT NAILS

To-day nails made from steel wire have almost superseded the use of cut and forged nails. They are made in a great number of kinds and sizes. The common varieties are known as 6 penny, 8 penny, 10 penny, etc., which meant at the time the name was given them, that 1,000 nails weighed five pounds, eight pounds, ten pounds, etc. Of late the sizes have been standardized in length, which makes the number in a pound somewhat different than formerly. The lengths are made to conform to the standard size of material, and to fit into the different places for which they are intended. We are indebted to The Aladdin Company for this data on nails.

Standard lengths of nails:

Sizes	2d	3d	4d	5d	6d	7d	8d	9d	10d	12d	16d	20d	30d	40d	50d
Length, ins.	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	6

All the kinds given in the tables are put up 100 pounds to a keg. Coated nails are from 70 to 80 pounds per keg.

NUMBER OF NAILS PER POUND

2 d. Galv.	800	16 d. Common	48
3 d. Fine	535	6—Finish	297
5 d. Box	243	8—Casing	245
8 d. Common	106	1¼" Brads	706
Roofing Nails	400		

All the nails which are purchased for your building are for a certain purpose, and the following table will serve as a guide in this connection.

Do not have your nails out over night, for if it should rain they will become rusty and hard to handle.

KINDS OF NAILS	TO BE USED FOR
2 d. Galvanized	Wood Shingles
Roofing Nails	Semi-Slate Shingles
3 d. Fine	Lathing
3 d. Fine	Plaster Board
5 d. Box	Siding
8 d. Common	1" Sheathing
16 d. Common	2" Material
20 d. Common	Timbers
8—Casing	Flooring, door and window frame and arge trim
6—Finishing	Ceiling, door and window frames and small trim
1¼" Brads	Base Shoe and small stops

MEASUREMENT OF HOUSEHOLD WATER SUPPLY

Water, when sold at a flat rate without direct measurement, is usually sold at so many cents per thousand gallons, and the quantity used by each consumer is measured by meter. The water meter is located in the supply line from the water main to the consumer's premises and is either placed indoors where the service enters the house or outside underground in front of the consumer's house in a box or manhole provided with a cover at the ground level for easy access. No water can reach the consumer except by passing through the meter, and all water passing through the meter is recorded whether it be used or wasted through leaks or otherwise. The usual water meter has a plurality of dials and is read in much the same manner as electric and gas meters, as explained elsewhere.

HEATING RULES AND FACTS

Add 65 per cent. to steam rating for water rating.

Deduct 40 per cent. from water rating for steam rating.

Under normal market conditions Hot Water Heating costs about 30 per cent. more than steam.

Under favorable conditions one square inch of grate is sufficient for one square foot of direct steam radiation in medium sized heaters, which radiation may be increased in larger and reduced in small heaters.

Divide the area of the grate by 8 to 10 for area of flue. No flue should be less than 6x6 or 7 inches round.

Doubling the diameter of a pipe increases its capacity four times.

A horse power is estimated equal to 100 sq. ft. of direct steam radiation or 165 sq. ft. of hot water radiation on 10 sq. ft. of fire surface in a cast sectional heater or 12 to 15 sq. ft. of fire surface in a steel ortubular heater. One horse power is that power required to raise 33,000 lbs. one foot per minute.

Water weighs $62\frac{1}{3}$ lbs. per cubic foot or $8\frac{1}{3}$ lbs. per gallon. and there are $7\frac{1}{2}$ gallons in a cubic foot.

Water pressure is 43 lbs. per hundred feet or $4\frac{1}{3}$ lbs. for each 10 ft., or nearly $1\frac{1}{2}$ lbs. for each foot in height.

Water freezes at 32° temperature.

Water boils at atmospheric pressure or sea level at 212° and in a vacuum at 98° , and its temperature is proportionately less.

Water expands $\frac{1}{10}$ by freezing and by boiling $\frac{1}{23}$.

Water evaporated expands about 1,700 times its bulk.

Water absorbs, also gives off, more heat than any other commonly known substance.

A heat unit, British Thermal Unit (B. T. U.), raises temperature of 1 lb. of water 1° and is $\frac{1}{180}$ of the distance between the freezing and boiling point of water.

A pound of anthracite coal contains 4,500 heat units.

996 heat units will evaporate 1 inch of water at 212° .

One square foot of grate in a low pressure steam heater will consume 3 to 5 pounds of anthracite coal per hour.

One square foot of grate in a high pressure steam boiler will consume about 12 pounds of anthracite coal per hour.

EVAPORATION—1 cubic inch of water evaporated under atmospheric pressure is converted into 1,642 cubic inches of steam.

COAL IN BIN—Anthracite coal requires 36 cubic feet of space per ton of 2,000 lbs.

Bituminous coal requires 40 cubic feet of space per ton of 2,000 lbs.

HEAT OF COMBUSTION

Substance.	Calories.	B. T. U.
Alcohol, ethyl	7,184	12,931
“ methyl	5,330	9,594
“ amyl	8,958	16,124
Benzene	10,030	18,054
Carbon, amorphous	8,080	14,544
Coal, bituminous	7,800	10,040
“ anthracite	9,000	16,200
“ lignite	7,800	14,040
Coke	6,900	12,420
Gas, coal	7,000	12,600
	4,440	7,990
	7,370	12,266
Acetylene	11,927	21,469
Ethylene	11,858	21,344
Methane	13,063	23,513
Hydrogen	34,462	62,032
Carbon monoxide	5,640	10,152
Oil, lard	9,300	16,740
“ olive	9,473	17,051
Wood, hard	4,750	8,550
“ soft resinous	5,050	9,090

A Calorie is the amount of heat required to raise 1 gramme of water 1 degree Centigrade.

A British Thermal Unit (B. T. U.) is the amount of heat required to raise 1 pound of water 1 degree Fahrenheit.

INFORMATION FOR APPLYING ASBESTOS BOILER COVERING

There is available at large hardware stores and steam fitting supply houses pure asbestos boiler covering which is very adhesive and one of the best non-conductors of heat known. It is very easily applied if the following simple rules are followed:

Asbestos covering should be applied to the boiler when the surfaces are warm. It will not adhere to a cold surface.

For the first coat mix the asbestos with water and apply to the surface of the boiler without regard to securing a smooth surface. It may be applied with a trowel or it may be thrown against the surface of the boiler.

After the first coat has set perfectly hard apply the second coat with a trowel, bringing this to a smooth surface. A fine skin coat or surfacing finish can be secured by mixing one-half plastic asbestos and one-half Portland cement. A coat of white lead and oil paint will give added protection and make a surface which can be easily washed off.

INFORMATION ON CHIMNEYS

Chimney flues must be of ample size and should be straight from near the cellar floor to above the highest projection of the roof. A square, brick flue is preferable to a rectangular on account of the greater friction in the latter.

The flue should be absolutely independent of all connections except the one at the heater. The following rule is considered fairly safe as a guide in average conditions.

Square feet	Square feet	Size of flue
Steam radiation	Water radiation	
200 to 300	400 to 600	8x 8
350 to 700	650 to 1000	8x12
750 to 1200	1050 to 2100	12x12
1250 to 2000	2200 to 3400	12x16
2100 to 3000	3500 to 5000	16x16

All chimneys larger than 12x16 should be fifty feet high or over; if not, a larger size will be necessary.

Never connect boiler to a flue having less than 6x6-inch inside dimension.

RULES FOR FIGURING HEAT RADIATION

Because of different conditions surrounding the installing of a heating apparatus, it is impossible to give any set rule that can be accepted without modification for all kinds of buildings to be heated. It is necessary to take into consideration all of the conditions in and around any building and additions or deductions made to suit the requirements, no matter what rule may be used for figuring.

Many contractors make the error of installing a too small amount of radiation. A little extra surface will give greater economy and insure a first-class working system as well as a pleased owner. An apparatus of ample size can be regulated to give economy, which cannot be done if the apparatus is too small and requires forcing.

FOR STEAM AND WATER HEATING

Rule No. 1

As this method of figuring only considers the cubical contents of space to be heated, some experience in heating is required to determine the proper factor to be used for different conditions. The exposed wall and glass surface varies the amount of radiation to be used.

ONE SQUARE FOOT OF DIRECT RADIATION WILL HEAT

Dwellings—	Cubic ft. by hot water	Cubic ft. by steam
Living rooms, one side exposed.....	25 to 30	45 to 50
Living rooms, two sides exposed.....	20 to 30	40 to 50
Living rooms, three sides exposed.....	20 to 25	35 to 45
Sleeping rooms	30 to 40	50 to 60
Halls and bathrooms.....	20 to 30	40 to 50

Rule No. 2

One square foot of radiating surface for each 2 sq. ft. of glass and for each 20 sq. ft. of exposed outside wall and each 200 cubic ft. of space.

EXAMPLE—A given room has 60 sq. ft. of glass, 220 sq. ft. of exposed wall and 2,000 cubic ft. of air. (Room is on first floor.)

Glass	$60 \div 2 = 30$ sq. ft. of radiation
Walls	$220 \div 20 = 11$ sq. ft. of radiation
Cubical contents	$2,000 \div 200 = 10$ sq. ft. of radiation

Total 51 sq. ft. of radiation

Above figures are for steam. For water (in accordance with accepted standards) add 65%.

Rule No. 3

Rule.—Add the area of the glass surface in the room to $\frac{1}{4}$ of the exposed wall surface and to this add from 1-55 to 3-55 of the cubical contents (1-55 for rooms on upper floors; 2-55 for rooms on first floor and 3-55 for large halls); then for steam multiply by .25 and for hot water by .40.

EXAMPLE—A room 20x12x10 ft. with glass exposure of 48 ft., $\frac{1}{4}$ of wall exposure (two sides exposed), 320 ft. = 80, 1-55 of 2,400 = 44.

$48 + 80 + 44 = 172 \times .25 = 43$ feet for steam.

If you add 2-55 the surface will be 54 ft.

If you add 3-55 the surface will be 65 ft.

Corrections should be made as in Rule 1.

FIRE RETARDANTS

The British Fire Prevention Committee has published the following formula for making curtains and draperies noninflammable:

2 pounds ammonium sulphate
4 pounds ammonium chloride
3 gallons water

It is probable that this solution will have to be applied after each washing.

Whitewash Fireproofing Mixture.—The following whitewash mixture (known as United States Government whitewash mixture) is often used as a fire-retarding coating over interior wooden surfaces:

Slake one-half bushel of quicklime with boiling water, keeping it covered during process. Strain and add 1 peck of salt dissolved in warm water; put 3 pounds of ground rice in water and boil to a thin paste; one-half pound of powdered Spanish whiting; 1 pound of clean glue dissolved in hot water. Mix well and let stand for several days. Keep in kettle or receptacle, and apply as hot as possible with a whitewash or paint brush.

MATERIALS REQUIRED FOR 1,000 Sq. Ft. OF SURFACE FOR VARYING THICKNESSES OF CONCRETE OR MORTAR

C. = Cement in Sacks.

F. A. = Fine Aggregate (Sand) in Cu. Ft.

C. A. = Coarse Aggregate (Pebbles or Broken Stone) in Cu. Ft.

Quantities may vary 10 per cent either way according to aggregate used.
No allowance made for waste.

Thick- ness in Inches	PROPORTION											
	1:1½		1:2		1:2½		1:3		1:1½		1:2:3	
	C.	F. A.	C.	F. A.	C.	F. A.	C.	F. A.	C. A.	C.	F. A.	C. A.
1½	18	27	15	30	13	32	11	34	18	27	65	130
1½	24	36	20	40	17	43	15	44	27	41	86	172
1½	36	54	30	60	23	63	22	68	41	55	106	212
1½	48	72	40	80	31	84	30	89	55	77	136	258
1½	60	90	50	100	42	105	37	111	68	97	156	312
1½	72	108	60	120	51	127	44	133	82	115	186	372
1½	84	126	70	140	59	147	52	157	97	135	215	432
2	96	144	79	158	68	169	59	177	111	156	258	516
2½												
3												
4												
5												
6												
8												
10												
12												

The above table will be found of value and real convenience in determining the approximate quantities of cement, fine aggregate or sand, and coarse aggregate or pebbles, for mortar and concrete of various kinds and for various purposes. Note the first column which indicates the thickness of the mortar and the concrete, ranging from a thin stucco coat to a foundation wall. The next four columns in

bold-faced rules indicate the various mixtures for mortars, using just the cement and the sand or fine aggregate. The balance of the bold-faced ruled columns indicate various mixtures for concrete. Elsewhere in this book will be found data dealing with the kinds of mixture for various purposes in which mortar or concrete is to be used, as well as directions for mixing and laying.



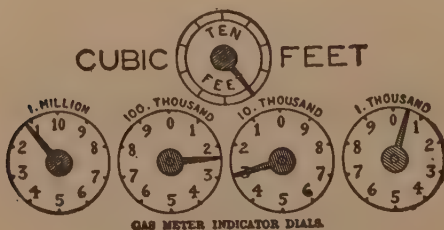
KILOWATT HOURS

HOW TO READ AN ELECTRIC METER

Electricity is measured by the Kilowatt hour (K.W.H.). There are usually four dials, each having its value marked above it. The numbers on the four dials which the respective pointers have passed are noted down from right to left. The reading so obtained is the amount of electricity that has passed through the meter since the last setting. The amount used since the last reading is the difference between the two readings. For example:

Meter above reads.....	1451 K.W.H.
If previous reading were.....	920 K.W.H.
Amount consumed	531 K.W.H.

Some meters have a note beneath the dial saying "Multiply by 10." In such cases the difference should be multiplied by this constant to obtain the K.W. hours.



GAS METER INDICATOR DIALS

HOW TO READ A GAS METER

The dial marked "1 Thousand" in the accompanying illustration is divided into hundreds; the dial marked "10 Thousand" is divided into thousands; that marked "100 Thousand" into ten-thousands, and that marked "1 Million" into hundred-thousands. When 1,000 cubic feet of gas have been consumed, the pointer on the dial marked "1 Thousand" will have made a complete rotation and the fact will be indicated by the pointer of the next dial at the left, which will point to the figure 1. When 10,000 cubic feet of gas have been consumed, the pointer on the "10 Thousand" dial will point to 1, and so on. The dial marked "Ten Feet" is called the units dial. It is used for testing the meter to discover whether it is in working order or not.

WHAT CAN THE PUBLIC DO TO DIMINISH THE FIRE WASTE

1. Keep *matches* out of the way of *children*. Teach them the dangers of playing with fire.

2. Avoid throwing *lighted cigars, cigarettes, and matches* into waste-paper baskets or other places containing inflammable materials.

3. Make it a point to *know how to get out* of every *building* you enter. This precaution may save panic and much confusion in case of fire.

4. Avoid the filling of *lighted lamps*. Avoid the use of *kerosene* to light fires. The application of heat to kerosene results in the generation of gases which are very explosive.

5. Provide a sufficient numbe of metal cans near stoves and furnaces to receive the *hot ashes*. Provide a different type of cans for *rubbish—never mix*.

6. Avoid *toy wax candles*. Each year the number of deaths of children due to placing *candles* on *Christmas trees* produces a sad ending for an otherwise joyful season.

7. Keep *greasy* and *oily rags* in tightly closed metal boxes provided in one place for the purpose.

8. Avoid hanging *lace curtains* and other draperies near *gas jets* or other open flames. The draft from near-by windows may cause fires quick to spread and difficult to extinguish.

9. Use *gasoline, naphtha, or benzine* for cleaning, if at all, out-of-doors and during the day. These liquids quickly evaporate, and the heavy inflammable gases formed quickly settle in spaces below windows and in corners.

10. Place substantial fire-resisting *guards* in front of all wood-work about *sources of heat*. The open flames of gas, kerosene, alcohol, and gasoline stoves should be particularly shielded.

11. Keep all *open flames* away from *gas leaks*. Explosive mixtures of gas and air are quickly formed at such places, and they only need a lighted match or taper to cause disastrous results.

12. Permit only experienced persons to *install* or repair *electrical fittings and appliances*. There are definite rules for wiring, which if known and observed will prevent electrical fires.

13. Avoid placing articles made of celluloid, pyralin, xylonite, fiberoid, viscoloid, and similar materials, such as collars, combs, toilet articles, etc., upon or near sources of heat, as they are very likely to cause fires. Great caution should also be exercised

when articles made of such materials are worn upon the person.

14. Turn the current off after using an *electric pressing iron*. Avoid leaving portable electric-heating devices unattended.

WHAT TO DO IN CASE OF FIRE

First. Collect your thoughts. Keep your mind on what you are doing. Act quickly.

Second. Summon help if anyone is within calling distance.

Third. If the blaze is small and you think you can put it out by devices which are available, either

(a) Use a fire extinguisher; or

(b) Use a woolen blanket or rug to smother the fire. Keep the air from the fire. Or

(c) Throw water on the fire from a pail, using a broom if it be conveniently at hand. If not, splash the water with the hands. Do not use water on an oil or grease fire; use sand or earth from flower-pots; use a carbon-tetrachloride extinguisher if available. Or

(d) Beat down any draperies, curtains, or light materials causing the blaze, using a broom or long pole. (Using the bare hands may cause serious burns. A wet broom is much more effective.)

(NOTE. It is very dangerous for women to stamp out fires on account of the nature of their clothing.)

Fourth. Unless you are very sure that you can handle the fire without help, notify the fire department or have some one else do this. Many have been sure until too late.

Teach each member of the family the method of sending in a fire-alarm. In many cities it is necessary only to call the fire department on the phone. In others it is necessary to send an alarm at a corner fire box. The methods employed for turning in alarms are often not understood, and as seconds count it is important that they should be studied before fires occur.

The telephone number of the fire department should occupy a conspicuous and permanent place at each phone. In giving information about a fire over the phone, one should carefully consider what he is doing. The few seconds lost in doing this are positively not wasted. What the fire department wants to know is (a) the number of the house, (b) the name of the street or road, and (c) the nearest street corner.

It is not surprising that in their excitement people give incorrect information at such times or else just say that the house is on fire. It is essential that the thoughts should be collected sufficiently to give adequate information before hanging up the receiver.

Fifth. Cut off all draft, closing doors, windows, and closets in the room, and use available methods of fire extinguishing as mentioned above.

Sixth. Tie a wet towel or any other material (preferably of wool) over the mouth and nose if you are fighting fire and

are exposed to smoke or flames. It is said that more people lose their lives by suffocation than through burning.

Seventh. Place yourself so that you can retreat in the direction of a safe exit without passing through the burning area. Unless you can do something worth while, get out of the building. Investigate afterwards.

Eighth. If necessary to go through a room full of smoke keep close to the floor. It is usually better to crawl on the hands and knees, keeping the mouth close to the floor. The drafts and currents cause the smoke to rise and the air nearest the floor is usually the purest.

Ninth. Do not jump from a high window. Use a rope or life line. To slide down a rope, twist the rope around one leg and, holding the feet together, regulate the speed of descent. Otherwise the hands may be painfully injured, especially if the height is great. Sheets and other articles of bedding will often provide a life line if knots are carefully made so that they will not slip. An extra loop in the knot may avoid this danger. Tie the rope or life line to a bed or other article of furniture which will not pull through the window. The line should not be thrown out of the window until the instant it is needed.

PERSONS WITH CLOTHING AFIRE.—A person with clothes afire will only make conditions worse by running. Particularly avoid running out of the house. Running fans the fire.

If your clothing is on fire, quickly wrap yourself in some heavy material and roll on the floor. A rug, shawl, bed cover, portiere, or coat will serve the purpose well. It is better to put out the fire in this manner than by the use of water, unless a considerable body of water is near.

If you see a person with clothing afire, wrap him up and roll him over. It will often be necessary to throw him down on the floor by force, due to the fear which the blazing clothing causes.

HOUSEHOLD FORMULAS

EXTERMINATION OF MOLDS IN CELLARS

Unslaked lime is best suited for this purpose. The same is blown, in the shape of fine powder, on the walls of the cellar and into the joints and crevices, by means of a bellows, or else thrown on with the hand. The walls must be damp; dry walls

have to be well moistened previously. The lime slakes with the adhering water and kills all organisms. On the day following the walls are washed off, and, as experience has proved, the cellar will remain free from mold for at least 2 years.

DUST CLOTH, OILED

1.—Saturate a suitable piece of cloth with kerosene, and lay it aside until the surplus oil has evaporated. Rub it on a wooden surface until it no longer leaves a streak, and it is ready for use. This cloth should be well shaken after each use, and re-oiled about once a month.

2.—Mix 30 parts of paraffine with 10 parts of double refined rape-seed oil, heat moderately, and stir into 1 part of melted benzoin (gum benjamin). Immerse the cloths in this liquid so as to become entirely saturated with it; wring out well, and dry in a shady place. The cloths do not injure even polished furniture, but rather enhance the brilliancy.

TO PREVENT HINGES CREAKING

Rub a little soap on the hinges; or, make a mixture of equal parts of lard, black lead and soap, and apply.

ICE

Keeping.—The use of ice in small quantities, frequently repeated, is very general in many diseases, but it is found difficult to keep it from melting, especially when in small blocks. To obtain this result, the ice should be put in a vessel covered with a plate, which vessel should be placed on a feather bed, and covered with a feather pillow or cushion; feathers being very bad conductors of heat. By this plan a few pounds of ice can be kept several days, even in summer heat.

Weight.—*Drug Topics* says that a close estimate of the weight of ice can be reached by multiplying together the length, breadth and thickness of the block in inches, and dividing the product by 30. This will be very closely the weight in lbs. Thus, if a block is 10 x 10 x 9, the product is 900, and this divided by 30 gives 30 pounds as correct weight. A block 10 x 10 x 6 weighs 20 lbs. This simple method can be easily applied, and it may serve to remove unjust suspicions, or to detect short weight.

PRESERVATION OF LINOLEUM, OILCLOTH, ETC.

Linoleum. Dressing for.—1.—A weak solution of beeswax in spirits of turpentine has been recommended for brightening the appearance of linoleum.

2.—Palm oil, 1 oz.; paraffine, 18 oz.; kerosene, 4 oz. Melt the paraffine and oil, remove from the fire and incorporate the kerosene.

3.—The *Bulletin de la Société Royal de Pharmacie de Bruxelles* gives the following directions for keeping linoleum mats bright: Treat first with a mixture in equal parts of milk and water. Let this dry on the surface, then apply the following mixtures: Yellow wax, 3 parts; carnauba wax, 6 parts; oil of turpentine, 30 parts; benzine, 31 parts. If the mat is subjected to much service the first preparation appears to be the best, while if but light, either of the others will answer.

Composition for Linoleum, Oilcloth and Other Coated Articles.—This is composed of whiting, dried linseed oil and any ordinary dryer, such as litharge, to which ingredients a proportion of gum tragacanth is to be added, replacing a part of the oil and serving to impart flexibility to the fabric and to the composition in a pastry mass the property of drying more rapidly. In the production of linoleum the whiting is replaced in whole or in part by pulverized cork. The proportions are approximately the following by weight: Whiting or powdered cork, 13 parts; gum tragacanth, 5 parts; dried linseed oil, $5\frac{1}{2}$ parts; siccative, $\frac{1}{2}$ part.

Polish.—a.—Yellow ceresin, $\frac{1}{2}$ oz.; paraffine, $2\frac{1}{2}$ oz.; boiled linseed oil, $1\frac{1}{2}$ oz.; oil of turpentine, 2 oz.

b.—White ceresin, 1 oz.; paraffine, 2 oz.; oil of turpentine, 5 oz.

c.—Palm oil, $2\frac{1}{2}$ oz.; carnauba wax, 5 dr.; yellow ceresin, $2\frac{1}{2}$ dr.; oil of turpentine, 6 oz.

d.—Take yellow wax, 5 oz.; oil turpentine, 11 oz.; amber barnish, 5 oz. Melt the wax, add the oil and then the varnish. Apply with a rag.

SINKS, CLEANLINESS OF.

One of the most prolific causes of defilement and offensive odors in kitchen sinks and their outlets is the presence of decaying grease. This comes from the emptying of kettles in which meat has been cooked, in the dish-water and in the soap. The grease lodges in every crevice and catches at every obstruction. A remedy may be found in the use of the common alkalis instead of soap, aqua ammonia in washing clothes, and borax in washing lawns and laces, and washing soda in cleaning dishes. These alkalis prevent a solid soap from forming in the sink and its pipes and neutralizes all effects of decomposing fat.

STOVE PIPES

Cleaning.—A piece of zinc put on the live coals in the stove will clean out the stove pipe.

Protecting.—Varnish with: Asphaltum, 2 lb.; boiled linseed oil, 1 pt.; oil of turpentine, 2 qt. Fuse the asphaltum in an iron pot, boil the linseed oil, and add while hot. Stir well and remove from the fire. When partially cooled add the oil of turpentine.

WASTE PIPES, CLEANING

One of the most frequent and trying annoyances of house-keeping, as many can testify, is the obstruction to the free, quick outlet of the waste water of the washstand, the bathtub, and the kitchen sink. This is caused by a gradual accumulation of small bits of refuse material, paper, rags, meat, bones, or other offal, which check and finally entirely stop the outflow of the waste water. A simple, inexpensive method of clearing the pipe is as follows: Just before retiring at night pour into the pipe enough *liquid* potash (not *soda*) lye of 36° strength to fill the "trap," as it is called, or bent portion of the pipe just below the outlet. About a pint will suffice for a washstand, or a quart for a bathtub or kitchen sink. Be sure that no water runs into it till next morning. During the night the lye will convert all of the offal in the pipe into *soft soap*, and the first current of water in the morning will remove it entirely, and leave the pipe as clean as new. The writer has never had occasion, in over thirty years' experience, to make more than two applications of it in any one case. The so-called potash lye sold in small tin cans in the shops is not recommended for this purpose; it is quite commonly misnamed, and is called caustic *soda*, which makes a *hard* soap. The lye should be kept in heavy glass bottles or demijohns, covered with wickerwork, and plainly labeled; always under lock when not in actual use. It does not act upon metals, and so does not corrode the pipes as do strong acids.

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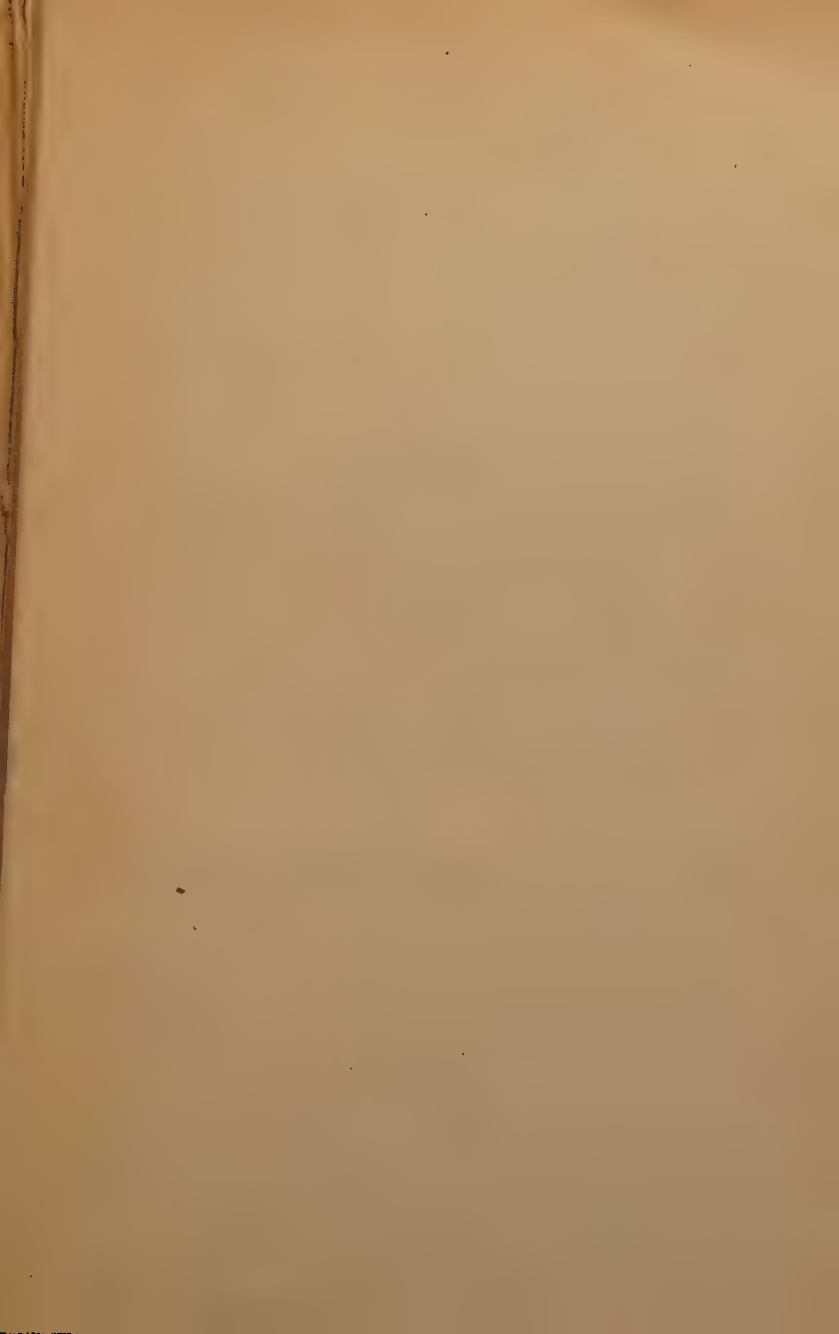
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